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BASAL METABOLISM FROM THE STANDPOINT OF RACIAL ANTHROPOLOGY

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When Eijkman (1896, '21) reported finding values for the oxygen consumption of Malay and European men in Batavia that agreed well with previously published values for normal men in Germany, the special object of his investigation was to study the chemical heat regulation in the tropics. The concept of a racial factor per se in metabolism was not advanced at that time, but survey of the literature indicates that, from the standpoint of respiratory exchange, the initial study in this field is represented by Eijkman's work. The results of Almeida ('21 a, '21 b, '24) are not in agreement with those of Eijkman. Almeida found that white men in Brazil had basal metabolic rates (B.M.R.) averaging 24 and 16% below American standards and that Negroes had rates only 8% higher than did the Whites in Brazil. Metabolism studies on normal individuals in many different parts of the world followed these studies of Eijkman and Almeida in rapid succession, and the investigations of Benedict and his co-workers gave particular impetus to consideration of the rôle played by race itself.

The claim that race is a factor in determining the level of basal metabolism appears to be based on three types of findings: (1) That the basal metabolism values found with different races of people in various parts of the world lie appreciably above or below the average normal standards established for Americans and Europeans, (2) that the metabolic rates of Chinese, Japanese, and South Indians are below the normal standards, even when individuals of these races are living in a temperate climate and leading the life of Westerners, and (3) that the basal metabolism of Whites living in the tropics either shows no deviation from normal standards or only a slight decrease or increase but in any event usually not so great a deviation as noted with native inhabitants of the tropics.

In the majority of such studies, minus values have been reported for the percentage deviations from the standards, but for Eskimos, American Indians, certain Javanese in mountain regions, the Miao race of Kweichow, and natives and Italians in Somalia deviations averaging

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higher than the standards have been reported. A summary of the results of the investigations in which plus values have been found is given in table 1, and a summary of the investigations in which minus values of more than 10% have been found is given in table 2. In both tables the results represent average values for several individuals in each racial group, and isolated values reported for single individuals have not been included. Between the two extremes represented by the data in tables 1 and 2 there are so many other values that space does not permit of summarizing them here. However, the reader will find tabular presentations of the data on the metabolism of different races published up to 1940 in the articles by Du Bois ('36), Goewie and Radsma ('37), Oliveiro ('37), Pretto ('38), Moura Campos ('38, '40), Albagli ('39), Sokhey and Malandkar ('39), Torres ('40 a), and MacGregor and Loh ('40). To bring these tabular summaries up to date insofar as possible the results of racial studies reported between 1940 and the present day (excluding those already cited in tables 1 and 2 and those on the effects of length of residence in the tropics by Europeans) are summarized in table 3. In all three tables the data are complete only insofar as publications have been accessible.

The same investigator sometimes has not obtained identical results when repeating his observations on the same race at another time. Heinbecker, for example, reported in 1931 that the metabolic rates of four Eskimo women living on a mixed diet were similar to normal standards, whereas in 1928 he had reported rates about 33% above normal standards with Eskimos (third day of fasting) who had been living on a purely meat diet. Hicks and his colleagues, in 1931, reported metabolic rates of −13% (males) and −11% (females) for aborigines of the Kokata tribe in South Australia, but in 1934 they reported that the rates of aborigines in Central Australia showed no essential departure from the normal. Different investigators, making their studies in the same locality on the same races, have sometimes drawn opposite conclusions. For example, Coro ('30) found for inhabitants of Havana, Cuba, rates similar to the Du Bois standards, in contrast to Montoro ('21), who found rates 13 to 15% below the standards. Similarly, Knipping ('23 a, '23 b) and Teding van Berkhout ('29), in contrast to Eijkman, found that native Malays in Batavia had rates below the normal standards.

In general, the metabolic rates of natives of certain parts of India and of Syria have been found to be distinctly lower than normal standards. The numerous investigations made in South America, chiefly in Brazil, Peru, and Argentina, show for the most part minus values, but

TABLE 1

Races having basal metabolic rates averaging higher than the normal standards.

RACE	INVESTIGATOR	SUBJECTS			STANDARD USED FOR COMPARISON	B. M. R. (P. CT.)
		No.	Sex	Age, yrs.		
Eskimos	Heinbecker ('28)	1	M	25–28	Aub-Du Bois	ca. + 33
		2	F			
Eskimos	Rabinowitch and Smith ('36)	7	M	15–60	Aub-Du Bois	+ 26
		3	F			
Eskimos	Crile and Quiring ('39 a)	30	M	15–85	Mayo	+ 14.5
		33	F	16–65	Mayo	+ 21.1
Eskimos	Levine ('37)	5	..	.....	.....	+ 19 to + 30
Maya Indians, Yucatan	Williams and Benedict ('28)	32	M	16–43	Harris-Benedict	+ 5.2
Maya Indians, Yucatan	Shattuck and Benedict ('31)	26	M	15–32	Harris-Benedict	+ 5.8
Maya Indians, Yucatan	Steggerda and Benedict ('32)	30	M	16–40	Harris-Benedict	+ 8.4
Araucanian Mapuches, Chile	Pi-Suñer ('33)	31	M	19–44	Harris-Benedict	+ 9.8
		14	F	18–45	Harris-Benedict	+ 14.8
American Indians, S. Dakota	Shaw ('33)	5	F	18–20	Harris-Benedict	+ 4.9
Chippewa Indians	Crile and Quiring ('39 a)	6	M	21–40	Mayo	+ 18.0
		7	F	15–50	Mayo	+ 18.5
Maya Quiché Indians	Crile and Quiring ('39 b)	30	M	18–33	Mayo	+ 8.2
		5	M	19–24	Mayo	+ 5.2
Navajo Indians	Salsbury ('39)	..	..	.....	.....	+ 2.4
Javanese (mountain districts)	Soetarman (Radsma, '38, '40)	31	..	.....	Harris-Benedict	+ 8.7
Miao race of Kweichow	Kilborn and Benedict ('37)	24	M	18–51	Harris-Benedict	+ 15.8
Italians, Somalia	Camis ('36)	..	..	.....	.....	+ 24.4
Natives, Somalia	Camis ('36)	..	..	.....	.....	+ 27.8

TABLE 2

Races having basal metabolic rates more than 10% below the normal standards.

RACE AND LOCALITY	INVESTIGATOR	SUBJECTS			STANDARD USED FOR COMPARISON	B. (P
		No.	Sex	Age, yrs.		
Americans						
New Orleans, La.	Hafkesbring and Borgstrom ('26)	7 2	M F	19–35	Harris-Benedict	—
Florida	Tilt and Waters ('35)	30	F	17–26	Harris-Benedict	—
Chinese						
South Hadley, Mass.	Turner and Benedict ('35)	8	F	20–35	Harris-Benedict	—
Honolulu, Hawaii	Miller and Benedict ('37)	21	F	19–25	Harris-Benedict	—
Singapore	MacGregor and Loh ('40)	50	M	21	Aub-Du Bois	—
Chinese-Hawaiian						
Honolulu, Hawaii	Miller and Benedict ('37)	16	F	16–22	Harris-Benedict	—
Cubans						
Havana, Cuba	Montoro ('21)	11	M	. . . . .	Aub-Du Bois	—
		5	F	. . . . .	Aub-Du Bois	—
Australians						
Immigrants and North Queenslanders	Sundstroem ('26)	8	M	24–58	Aub-Du Bois	—
		6	F	25–40	Aub-Du Bois	—
Aborigines	Wardlaw and Horsley ('28)	8	M	35–65	Aub-Du Bois	—
Aborigines	Wardlaw and Lawrence ('32)	2	M	67–69	Aub-Du Bois	—
Aborigines (C. Austr.)	Wardlaw at al. ('34)	10	M	17–65	Aub-Du Bois	—
Aborigines (Kokata)	Hicks et al. ('31)	40	M & F	9–41	European	— 11
Indians						
Bombay, India	Niyoki et al. ('40)	35	M	11–16	Aub-Du Bois	—
Bombay, India	Niyoki et al. ('39)	24 52	M F	18–35	Harris-Benedict	—
Madras, India	Mason and Benedict ('31)	54	F	17–31	Harris-Benedict	—
Madras, India	Krishnan and Vareed ('32)	54 15	M F	18–25	Harris-Benedict	— —
Calcutta, India	Mukherjee and Gupta ('31)	18	M	20–29	Aub-Du Bois	—
Calcutta, India	Wilson and Roy ('38)	. .	M	6–16	Aub-Du Bois	—
Coonoor, S. India	Rajagopal ('38)	28	. .	22–52	Aub-Du Bois	—
Tamils						
Singapore	MacGregor and Loh ('40)	50	M	22	Aub-Du Bois	—
Brazilians						
Rio de Janeiro						
Native whites	Almeida ('21 a)	10	M	23–40	Aub-Du Bois	—
Whites (?)	Almeida ('24)	8	M	21–46	Aub-Du Bois	—
Whites	Azambuja ('35)	7	M	22–33	Aub-Du Bois	—
		2	F	22–37	Aub-Du Bois	—
Whites (?)	Lobato ('18)	. .	. .	. . . . .	Aub-Du Bois	—
Negroes	Almeida ('21 b)	10	M	20–44	Aub-Du Bois	—
São Paulo						
Mulattoes	Camargo ('34)	. .	. .	. . . . .	Aub-Du Bois	—
Brazilians	Oliveira, D. ('33)	18	M	. . . . .	Aub-Du Bois	—
Whites, blacks, and browns	Moura Campos and Paula Santos ('28, '38)	79	M F	11–18	Aub-Du Bois Aub-Du Bois	— —
Recife						
Brazilians	Castro ('38)	15	M	19–44	Aub-Du Bois	—
Syrians						
Beirut, Syria	Turner and Aboushadid ('30)	24	F	17–33	Aub-Du Bois	—
Batavia (Weltevreden)						
Malayans	Teding v. Berkhout ('29)	12	M	19–38	Aub-Du Bois	—

TABLE 3

Results of racial studies reported between 1940 and 1942.

LOCALITY AND RACE	INVESTIGATOR	SUBJECTS			STANDARD USED FOR COMPARISON	B. M. R. (P. CT.)
		No.	Sex	Age, yrs.		
Batavia						
White immigrants	Radsma ('40)	78	..	.....	.....	— 6.0
Dutch Indies						
White native students	Radsma ('40)	18	..	.....	.....	— 1.7
Salvador, Bahia						
Natives	Albagli and Torres ('40)	77	M	15–48	Aub-Du Bois	— 7.1
Natives	Albagli and Torres ('40)	23	F	19–75	Aub-Du Bois	— 2.4
São Paulo, Brazil						
Brazilians, Italians,	Torres ('40 b)	43	M	20–50	Aub-Du Bois	— 6.8
and Spaniards	Torres ('40 b)	114	F	20–50	Aub-Du Bois	— 2.4
Whites, Negroes, and Mulattoes	Orsini ('40)	242	M	8–18	Aub-Du Bois	— 7.8
Rio de Janeiro, Brazil						
Whites (Brazilians)	Oliveira, R. M. ('40)	60	M	21–46	Aub-Du Bois	— 2.9
Bello Horizonte, Brazil						
Brazilians	Viégas ('40)	48	M	20–30	Boothby	— 3.0
Buenos Aires, Argentina						
Different nationalities	Castex and Schteingart ('40)	250	M & F	10–20	Aub-Du Bois	— 0.5
		750	M & F	21–30	Aub-Du Bois	— 0.6
		600	M & F	31–40	Aub-Du Bois	+ 0.1
		330	M & F	41–60	Aub-Du Bois	+ 0.3
		70	M & F	60 +	Aub-Du Bois	+ 5.2
Bombay, India						
Indians	Niyogi et al. ('40)	35	M	11–16	Aub-Du Bois	— 15.8
					Harris-Benedict	— 5.5
Singapore						
Europeans	MacGregor and Loh ('40)	70	M	23	Aub-Du Bois	— 5.4
Malays		50	M	21	Aub-Du Bois	— 9.9
Javanese		19	M	29	Aub-Du Bois	— 5.0
Batak		11	M	19	Aub-Du Bois	— 3.3
Sikh		50	M	22	Aub-Du Bois	— 5.4
Punjabi		9	M	20	Aub-Du Bois	— 9.7
Sourabaia						
Indo-Europeans, East Indians, & Chinese	Streef and Karmawan ('42)	38	M	..	Boothby	— 9.0

the majority of them are close to the standards. The data for Japanese and Chinese show rates on the minus side, and these have been inter preted both as indicating a metabolism lower than the western stand ards and the same as these standards. Studies on Japanese in Japan California, and Hawaii show that they have a low basal metabolic rate in three different geographical localities, and it has been suggested tha racial characteristics are retained hereditarily, so far as the basa metabolism of Japanese is concerned (Baldwin and Fujisaki, '39). A study of Syrian women has also led to much the same conjecture namely, that there may be an inherited metabolic level independent, to a certain extent, of environmental conditions (Turner and Aboushadid '30).

In the belief that climate rather than race may be an explanation of the varying results, studies have been made on Europeans in their native country and subsequently after residence for short and long periods of time in the tropics. The results have shown that the tropica climate causes no change, an increase, or a decrease in the metabolism of Europeans, apparently dependent on the length of stay in the tropics

There are probably as many investigators who claim that race plays no significant rôle in basal metabolism as there are those who claim tha race is a factor. That the problem is complex and that the data avail able today are inadequate to solve it is emphasized by the directly op posite conclusions derived from the same data by two such eminen authorities as Lusk and Du Bois. Lusk ('28) states:

> Evidently life at the equator has the same basal metabolism as in temperate climes. All this is not surprising, for our stock presumably arose in tropical waters many millions of years ago, and we have pre served our heritage. In the future the same level of basal metabolism may be established for man in a laboratory at the North Pole. . . On the basis of the whole of the evidence it does not appear wise to state that the influence of race or of a tropical climate may greatly re duce the basal metabolism.

Du Bois, in 1936, when reviewing the studies on racial metabolism wrote:

> In summarizing these results, it seems clear that there are distinc racial differences in metabolism apart from the effects of climate . . . No satisfactory explanation has been offered for the racia differences.

In 1930, however, Du Bois did not place so much stress upon the racial factor, for he stated:

After all, one gets the impression that the racial differences are so slight that they are almost entirely obscured by the factors of repose, physical training, and nutrition.

In view of the divergence of opinion among investigators regarding the existence of a racial factor in metabolism, is seems desirable to review the explanations and suggestions made by them as to other factors that might be accountable in whole or in part for the lack of uniformity noted in the metabolic levels of different races of people.

FACTORS SUGGESTED AS EXPLAINING THE DIVERGENCE IN THE CONCLUSIONS DRAWN FROM RACIAL STUDIES

Technique. Of the many factors that have been suggested as possibly accounting for the divergence in the findings, the most obvious perhaps are the differences in the techniques employed for measurement of the respiratory exchange and the possibility of errors in these techniques. Among the types of respiration apparatus that have been used in studies of racial metabolism are the Zuntz-Geppert apparatus, the Tissot gasometer, the Douglas bag and Haldane apparatus, the Krogh, the Knipping, the Benedict-Atwater-Kestner, the Benedict-Roth-Collins, the Benedict-Sanborn, the Jones, the Benedict field, and the Benedict helmet respiration apparatus. Even if it is admitted, however, that there may be inherent errors in the various types of respiration apparatus employed, these errors can hardly be great enough to account for all the difference between a basal metabolic rate of + 26%, for example, found with Eskimos by Rabinowitch and Smith ('36) and rates of — 31 to — 33% found with aborigines of Australia by Wardlaw and co-workers ('28, '32).

Functional normality. In any racial comparisons the functional normality or abnormality of the subjects studied should be taken into consideration. As Hobson ('23) has pointed out, however, there is no way of forming an opinion as to the nutritional and functional normality of individuals except by comparisons with average height-weight tables and the assumption that they are normal in the eyes of the observers. Various indices of fitness upon which such an assumption may be based are not only body weight but, for example, vital capacity, pulse rate, respiration rate, body temperature, and the blood picture. Mason ('34, '40), in studying European women in both temperate and tropical climates, found a high correlation between mouth temperature and metabolic response to the tropics. The importance of the blood picture has been stressed by Levine ('37), Rabinowitch and Smith ('36), and Streef and Karmawan ('42). Levine found anemia common among

Alaskan Eskimos. Of those studied by him, the majority had normal metabolic rates but some had high rates. Seven of a group of twelve Eskimos revealed a blood picture indicating marked anemia. Levine believes that in anemia the metabolic rate may vary as a result of various factors. Streef and Karmawan report that anemia gave clearly too high basal rates with East Indians and Chinese in Sourabaia. Rabinowitch and Smith observed that polycythemia is common among Eskimos, that some of those they studied had this condition, and this may have been a factor in the high basal metabolism found with them.

An unexpected negative correlation has been noted in comparisons of pulse rate with metabolic rate. High metabolic rates accompanied by low pulse rates have been recorded by Benedict and his co-workers (Williams, '28; Shattuck, '31; Steggerda, '32) for Maya Indians of Yucatan, by Pi-Suñer ('33) for Araucanian Mapuches, by Crile and Quiring ('39 a, '39 b) for Chippewa Indians, by Soetarman (Radsma, '38) for Javanese, and by Kilborn and Benedict ('37 a) for the Miao race of Kweichow, the only Asiatic race thus far reported with basal metabolic rates higher than the Occidental standards.

A high incidence of diffuse endemic goiter was found by Crile and Quiring ('39 b) among Maya Quiché Indians, whose metabolic rates were high. That the activity of the thyroid gland may play a rôle in the differences in metabolic rates of races has been suggested. In 1923, Knipping advanced the theory that the decrease in metabolism after long residence in the tropics might be accounted for, in addition to chemical heat regulation, by involvement of the internal secretory organs. Two years later, Earle stated that the reduced basal metabolic rate of the Chinese means that the Chinese university student is hypothyroid when compared with his western brother, that the basal metabolism varies with height, weight, and the like, but appears to depend mainly, if not entirely, on the thyroid secretion. At about the same time Sundstroem ('26) made the interesting conjecture that the mechanism whereby the organism can adjust its combustion in conformity with changes in the cooling power of the air is entrusted to some endocrine glands, for instance the thyroids. He suggests that the thyroid secretion might be subject to seasonal influences in the tropics similar to those demonstrated in temperate climates, that during the hot season conditions might be favorable for a normal thyroid secretion which, in its turn, would keep the energy metabolism at a higher level, and that during the oppressive weather, when conditions are unfavorable for proper exercise of endocrinal activities, these functions would suffer

considerable impairment, which again would reflect upon the extent of cellular combustion.

Climate. That climatic factors such as temperature, humidity, atmospheric pressure, and season influence the metabolism is suggested by many investigators. Almeida ('21 a) concludes that the lower metabolism noted with white men in the tropics represents an adaptation to a warm climate and, up to a certain point, constitutes an advantage in the struggle against high temperatures. When Sundstroem ('26, '27) looked for a compromise between the opinions held by previous investigators with respect to the effect of tropical climate on respiratory metabolism, he found that those research experiments in the tropics that were performed at seasons immediately subsequent to hot periods gave evidence of abnormally low metabolic rates. He suggests that the energy metabolism in the tropics may be subject to seasonal variations, which would explain the divergence in the findings of investigators in the tropics. Hindmarsh ('27) thinks that climate may be indirectly responsible for low metabolic rates because of the more ready muscular relaxation of individuals in a warm climate. Ocampo and his colleagues ('30) suggest that climate is, in the last analysis, responsible for the different levels of metabolism of different racial groups, but that such an influence becomes manifest only after generations of adaptation or at any rate after a longer period than the span of an ordinary adult life-time. Krishnan and Vareed ('32) conclude that climate may not affect metabolism directly but does so indirectly by virtue of habits and activities acquired. From a comparison of Indian women studied in a temperate climate as well as in their native climate, Mason ('34) concludes that approximately 5% of the low metabolic rates noted in India may be due to climate. Banerji ('31) and Rahman ('36) suggest that humidity may be a factor in lowering metabolism. Rabinowitch and Smith ('36) believe that the high metabolic rate of the Eskimo fits in with the cold environment, which is known to increase metabolism, that constant stimulation of cold weather should theoretically tend toward increased muscle tone, and that the basal metabolism is to a large extent a function of active protoplasmic mass. Rajagopal ('38) noted that the metabolism of Indians who had lived 3 years in the cool, dry climate of the hills in Coonoor was significantly higher than that of some Indians who had lived there only 2 months. Teruoka ('35) emphasizes the necessity for attention to geographical differences of the country in respect to seasonal and climatic influences. MacGregor and Loh ('40), from their careful study of inhabitants of Singapore, conclude that climate is an important fac-

tor in bringing about a lowering in metabolism. Albagli ('40), on the other hand, believes that the basal metabolism of normal individuals, properly fed, is independent of climate and is equivalent in Brazil, as everywhere, to the classical American or European standards.

Diet. The rôle played by diet from quantitative and qualitative standpoints has been constantly held in mind by investigators of racial metabolism. Albagli ('40) emphasizes that the factor governing the modifications of basal metabolism is the habitual alimentary ration. Lusk ('28) points out that undernutrition as a factor by itself may reduce the basal metabolism one-third and that this must always be vividly borne in mind in racial studies. Hicks and Matters ('33) conclude that undernutrition might be one of the causal factors in the low basal rates noted with Australian aborigines. Niyogi and his colleagues ('40), on the other hand, believe that the low rates of Indians in Bombay are not ascribable to undernutrition. MacGregor and Loh ('40) state that there seems to be no evidence that the amount of food consumed in a tropical country is below that in a temperature climate, provided the source of supply is not limited. Their data do not suggest that increased diet plays an important rôle in bringing about an increased metabolic rate, provided that the diet is already adequate and the health and the physique of the subjects are not below the normal standard. A study of the food habits and the composition of the food of the present-day Maya Indians (Benedict and Steggerda, '36) indicates that their food is chiefly carbohydrate (maize) and their daily energy intake is not excessively high. Their high basal metabolic rate cannot, therefore, be explained by a protein-rich diet or one high in energy content. On the other hand, a study of the food habits of the present-day Navajo Indians (Carpenter and Steggerda, '39) shows that their food is predominantly protein (mutton), and yet what little information is thus far available regarding their metabolism (Salsbury, '39) indicates that their basal metabolic rate is only about + 2.4%. Heinbecker attributes the higher metabolic rates of Eskimos found in his first study ('28) to their meat diet and the lower, normal rates noted with other Eskimos in his second study ('31) to their mixed diet. Rabinowitch and Smith ('36) pointed out that Eskimos are largely carnivorous in their dietary habits, and so there is an added factor of the high specific dynamic action of protein. Krishnan and Vareed ('32) attribute the low rates noted in Indians in Madras largely to their low protein diet. Other investigators who ascribe low metabolic rates in part or in whole to low protein intake include Sokhey and Malandkar ('39), Wilson and Roy ('38), and Mason and Benedict ('31). Radsma and Streef ('32),

on the other hand, could not attribute the lower values found for Europeans living in the tropics to differences in protein intake nor most probably to differences in fat and carbohydrate intake. Oliveiro ('37) also thinks that protein intake plays no rôle. Fleming ('23) believes there is evidence both for and against the low basal metabolism being due to a low protein intake. Pi-Suñer ('33), who found high rates with Araucanian Mapuches in Chile, states that their diet was poor in protein.

Social milieu. Goewie and Radsma ('37) comment that little attention seems to have been given to the possible differences in basal metabolism in persons coming from different social milieux. It seems evident to them, from the literature on the subject, that in Europe and America there are no great differences in social milieu, but they believe this does not exclude the possibility that in countries where the standards of life of the varying classes of society are more widely different, such differences might occur.

Degree of physical activity and muscular relaxation. Almeida ('21 b), who found that Negroes in Brazil had metabolic rates about 8% higher than Whites in the same place, believes that the difference between the two groups is probably ascribable to differences in the customary degree of physical activity. He points out that the Negroes did physical work for a living, whereas the Whites lived intense intellectual lives. The strong muscular development of the Javanese subjects studied by Soetarman is believed by Radsma ('38) to be perhaps partly the cause of the high metabolic rate noted with them. MacGregor and Loh ('40) do not believe that increased exercise plays an important part in increasing the metabolism, if the diet is already adequate. Hindmarsh ('27) believes that the lower metabolic rates obtained on untrained subjects in warm and hot climates must be regarded as an acclimatization factor, that this factor consists in a more ready production and maintenance of muscular relaxation, so that in climates where heat loss is more difficult there is, during rest, a lessened production of heat, that the acquiring of this habit of ready relaxation takes time to become established in the body and is more readily seen in individuals born in warm climates than in those who have migrated there after having adjusted their heat production to a cooler climate. Necheles ('30) points out that the average Chinese is more relaxed than the average Westerner, that the muscular tone of the Chinese seems to be constantly lower than that of Westerners, and he conjectures that this might be the reason for their lower basal rates. This hypothesis seemed to be confirmed by his observations, which showed little difference in the basal metabolic rates of Chinese when awake and when asleep but a considerable drop in the

rates of Westerners during sleep. Mason and Benedict ('34), however, in observations made under conditions meeting more strictly the requirements essential for the study of sleep (successive experimental periods on the same day with subjects when soundly asleep and when fully awake) found that South Indian women showed a decrease in oxygen consumption during sleep averaging 10%. As this decrease is of the same magnitude as that indicated for Westerners, they conclude that the state of relaxation is not a causal factor in the low basal metabolism noted with South Indian women when awake. Krishnan and Vareed ('32) put forward the view that the low rates of Indians in Madras are in part ascribable to the ready muscular relaxation in the hot tropical climate and suggest that the low rates found by MacLeod, Crofts, and Benedict ('25) in Oriental women resident in the United States might be explained to some extent by the fact that the Orientals continued to have approximately the same degree of muscular relaxation as they used to have in their own country.

Anthropometric measurements. In future basal metabolism studies on Chinese growth must be considered as a factor, according to Necheles ('28), for it is not improbable that climate affects growth. Hence the provincial origin of Chinese must be carefully ascertained in all cases. The theory that a weedy bodily shape may be beneficial to heat regulation is referred to by Sundstroem ('27). Hicks and his colleagues ('31, '33, '34) conclude that bodily shape might be one of the causal factors in the deviations from European standards noted with Australian aborigines. It was apparent to them that they were dealing with a special bodily configuration in these aborigines and that the pelidisi was not an accurate index of state of nutrition, so far as these subjects were concerned. The high pelidisi values found for the Kokata tribe point to a shorter leg length, which they believe may have some anthropological significance. The differences in the metabolic rates of Italians in different provinces of Italy are not explained, according to Felloni ('36), by the frequency of the constitutional types. Genna ('38 a, '38 b), in reporting his study of natives in Tripoli, briefly touches upon the racial differences in metabolism in connection with anthropometric measurements. He thinks there is reason to believe that reduction of stature and other anthropometric quantities with age vary with race, but he considers that the anthropological aspect of basal metabolism is not yet represented by sufficient data.

Anthropological and constitutional types. Albagli ('39) grouped his data on Brazilians in Rio de Janeiro according to anthropological and constitutional types and obtained the average results given in table 4,

which he considers concordant and normal. R. M. de Oliveira ('40) also grouped his data on Brazilian naval pilots according to constitutional type and, like Albagli, found somewhat higher metabolic rates for the "brevi-" and lower for the "longi-types". His results are also given in table 4. Moura Campos and Paula Santos ('28), who found a lower basal metabolism in colored people than in white people in São Paulo, Brazil, believe that the color of the skin must play some important rôle. Almeida ('21 b), on the contrary, concludes that the black color of the skin plays no appreciable rôle.

TABLE 4

Basal metabolic rates of Brazilians according to anthropological and constitutional types — Albagli and Oliveira.

INVESTIGATOR AND CLASSIFICATION	MEAN DEVIATION FROM STANDARD OF		
	Du Bois	Krogh	Boothby
Albagli ('39)			
Anthropological			
Whites	— 5.4	+ 0.8	— 5.7
Negroes	— 4.1	+ 2.0	— 4.5
White + Negro	— 4.9	+ 1.5	— 4.8
White + Indian	— 4.2	+ 2.3	— 3.8
Constitutional			
"Longi-type"	— 5.0	+ 0.9	— 6.0
Normal type	— 5.7	+ 0.5	— 5.5
"Brevi-type"	— 4.8	+ 1.7	— 4.7
Oliveira ('40)			
Constitutional			
"Longi-type"	— 4	+ 1.3	— 5.9
Normal type	— 2.8	+ 3.3	— 3.7
"Brevi-type"	— 0.9	+ 5.3	— 1.8

Normal standards. Another factor to be taken into consideration is the normal standard with which the racial findings have been compared. Not all investigators have used the same standard for comparative purposes, some preferring the Harris-Benedict, some the Aub-Du Bois, others the Dreyer, still others the Mayo modification of the American standards, and some of the earlier investigators making use of the data obtained on Germans by such investigators as Geppert, Loewy, and Magnus-Levy. All these standards, however, are based on data obtained in temperate climates, particularly in the United States, with well-nourished people in good health who took a mixed diet. It is question-

able, therefore, whether these standards are applicable for races in the tropics, sub-tropics, or arctic regions, where the climate and the dietary habits are different. Furthermore, the three commonest methods of predicting the normal basal metabolism (Benedict, Du Bois, and Dreyer), although agreeing upon the character of the fundamental factors that influence metabolism, namely, sex, age, and body size, disagree in their method of treating body size. Herein lies a possibility for disagreement in the racial comparisons. In the Du Bois standard the basal metabolic rate is related to surface area, but it cannot reasonably be suggested from comparisons with this standard that a racial difference in metabolism exists unless the surface area of the race in question has been shown to bear the same relationship to weight and height as has been demonstrated for Caucasians. Necheles and Loo ('32) took pains to test the Du Bois height-weight formula for Chinese and conclude that it is not necessary to alter the constants of the Du Bois height-weight and linear formulas for the Chinese. However, as Earle ('28) points out, although the technique of measuring surface area has been greatly improved and simplified by the work of Du Bois and his co-workers, still the fact remains that even in the case of skilled observers measurement or calculation of surface area can never be more than an approximation. Another point to be held in mind is that the several standards in current use may be too high. In fact, Benedict ('28) believes that the standards for American women are about 5% too high, and Du Bois and Chambers ('42, '43) are of the opinion that the Aub-Du Bois and the Mayo standards could be lowered 5 to 8% and the Harris-Benedict standard about 3%. They hope that some day there will be more satisfactory physiologic standards but think that in spite of the thousands of basal metabolism measurements already made on normal individuals, it is too soon to settle on a new level, because the average normal is still falling slightly every decade.

SUMMARY

From this survey it is apparent that so many different factors may play concurrent rôles in affecting the basal metabolism that it is impossible at the present time to say whether the different levels of basal metabolism noted with the various races thus far studied are reflections of a racial characteristic alone or are the results of a combination of some or all the factors just mentioned, or even of factors thus far unsuspected. It would be ideal if studies of different races could be made with the same technique by the same investigator or group of investigators, as this would rule out at least the factor of difference in tech-

nique. This has already been done to some extent, as evidenced by studies on Maya Indians, on Browns and Blacks in Jamaica, on several different races in Hawaii, and on Chinese in different parts of China, studies carried out by investigators working in cooperation with the Nutrition Laboratory of the Carnegie Institution of Washington (Williams and Benedict, '28; Shattuck and Benedict, '31; Steggerda and Benedict, '28, '32; Miller and Benedict, '37; Kilborn and Benedict, '37 a, '37 b; Benedict and Garven, '36; Benedict, Kung, and Wilson, '37). It would also be ideal if many more details could be recorded in future racial studies with regard to the several factors of climate, nature and amount of food intake, physical activity, anthropometric measurements, and the other factors discussed in the previous pages of this review. In view of the complexity of the problem and the lack of agreement at the present time in the interpretation of the findings in racial studies, it would be desirable to establish a normal standard for each individual race, based on measurements of normal individuals of the race in their native country. Steps in this direction have already been taken by some investigators. When such standards have been established for many different races, a comparison of these with the American and European standards should throw more light on the rôle played by race in basal metabolism.

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THE KEILOR SKULL: A WADJAK TYPE FROM SOUTHEAST AUSTRALIA

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THREE FIGURES

The greater part of the September issue of the Memoirs of the National Museum Melbourne (no. 13, '43) deals with the discovery of a fossil skull (Keilor skull) which was found in 1940 in a sand pit near a place named Keilor, 10 miles northwest of Melbourne. In an introductory article D. J. Mahony took the opportunity to review all earlier finds of fossil man in Australia and discuss the entire problem of his antiquity on this continent. Then follows the anatomical description of the skull by J. Wunderly. Its palate and upper dental arch are the subjects of a separate paper contributed by W. Adam. This series of articles is concluded by a second paper by Mahony dealing with the geological evidence of the antiquity of the skull.

All the authors, and particularly Mahony, stress the importance of the discovery because of the old geological age ascribed to the skull, but none of them, nor the later reviewers of the articles (Wood Jones, Keith) recognized that the significance, regardless of its debatable age, lies in the fact that the skull is a duplicate of the Wadjak skull found in 1889 near the south coast of Java, which was described by Eugène Dubois in 1922.

Let us put aside for a moment the geological age and consider first the morphological character of the skull. Wunderly compared it with Australian skulls from six regional groups and localities, two Tasmanian skulls, several skulls of Melanesians and Polynesians, and arrived at the following conclusions: (1) the skull combines Australoid and Tasmanoid characteristics in about equal proportions; (2) the form of its contour closely resembles that of a South Australian male skull; (3) the individual was of middle age.

It seems to me of little use to enter into a detailed description of the skull and to discuss the similarities and dissimilarities between the Keilor skull and the skulls of those races of which examples have been picked by Wunderly. Instead, I have listed in table 1 some of the linear measurements of the Keilor skull as given by Wunderly or computed

by myself on the basis of Wunderly's craniograms (figs. 1, 2), and set them side by side with the corresponding measurements of the Wadjak Skull I given by E. Dubois in his publication ('22) or measured from a cast by myself.

TABLE 1

Main linear measurements (in mm.) of the braincases of the Keilor skull, the Wadjak skull I, and the Talgai skull.

MEASUREMENTS	KEILOR [1]	WADJAK I		TALGAI [4]
		Original [2]	Cast [3]	
Maximum length	197	200	200	192?
Nasion-basion line	109	107	104	...
Nasion-opisthion line	146	...	145.5	...
Maximum breadth	143	145	149?	141
Minimum frontal breadth	101	99	100	99
Biauricular breadth	135.5	...	133?	...
Biasterionic breadth	108	...	114?	...
Basion-bregmatic height	143	140	140?	...
Auricular height	120	...	118	105?
Horizontal glabellar circumference	544	...	545?	...
Transverse bregmatic arc	319	...	322?	...
Nasion-opisthion arc	389	...	340?	...
Nasion-bregma arc	128	136	...	...
Bregma-lambda arc	129	130	...	...
Lambda-opisthion arc	132	...	127?	...
Nasion-bregma chord	114	119	...	...
Bregma-lambda chord	120	113	...	...
Lambda-opisthion chord	107	...	...	...
Cranial capacity in cc.	1593	1550	...	1300

[1] Wunderly, '43. [2] Dubois, '22. [3] Personal measurements. [4] Smith, '18.

Since in the Wadjak skull the occipital region and the right side are considerably damaged and Dubois' reconstruction leaves much to be desired it is impossible to given even approximately correct figures of the individual cranial bones in question. However, considering the character of the whole skull I do not deem this failure to be of great importance, for the main measurements and the capacity agree so completely that the racial identity of the two skulls cannot be doubted.

The conformity of the two skulls appears still more astonishing when their mid-sagittal diagrams are superimposed on the glabella-opisthocranion line (fig. 1). The outlines of the brain cases are practically the same and the Frankfort Horizontals run almost parallel to the glabella-opisthocranion lines and are approximately the same distance from them. But there are some interesting differences: (1) the total and auricular

heights of the Wadjak skull (basion-bregmatic and basion-vertex) are a little smaller than those of the Keilor skull as indicated by the position of basion and porion; (2) the glabellar region is heavier and projects more in the Wadjak skull than in the Keilor skull; (3) the frontal squama of the Keilor skull shows more vaulting and is more erect than

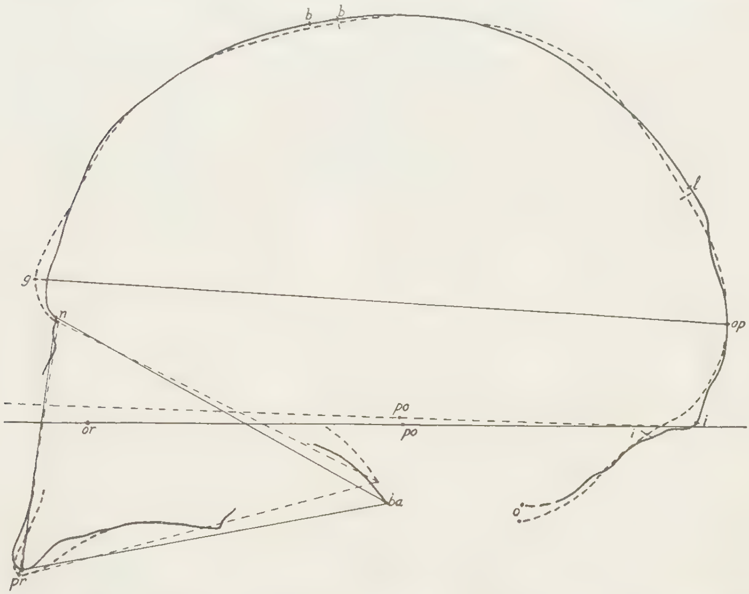

Fig. 1 Mid-sagittal craniograms of the Keilor skull (——), copied from Wunderly's pl. VII ('43), and the Wadjak skull II (- - -), taken from a cast, both superimposed on the glabella opisthocranion line (g-op) and the opisthocranion. × ½.

that of the Wadjak skull. The transverse interporial diagram (fig. 2) of the two skulls corroborates the identity as shown by the mid-sagittal diagram. The Wadjak skull appears on the whole to be broader, but this could also be the result of a natural asymmetry or an artificial deformation caused by the crushing of the skull and its unsatisfactory reconstruction.

Indeed, the main indices (table 2) show only minor deviations. The length-breadth indices are identical (72.6 in the Keilor skull against 72.5 in the Wadjak skull I). The two length-height indices (total height and auricular height differ to a very small extent (72.6 and 60.8, respectively, in the Keilor skulll against 70.1 and 59.0 in the Wadjak skull). This means that the Wadjak skull is a little lower than the Keilor skull.

That the latter is more vaulted than the former can be seen from the index of the sagittal cranial curvature: it is 37.8 in the Keilor skull and 42.8 (?) in the Wadjak skull, while the transverse index is about the same in both skulls (42.5 against 41.8). As said before, however, the

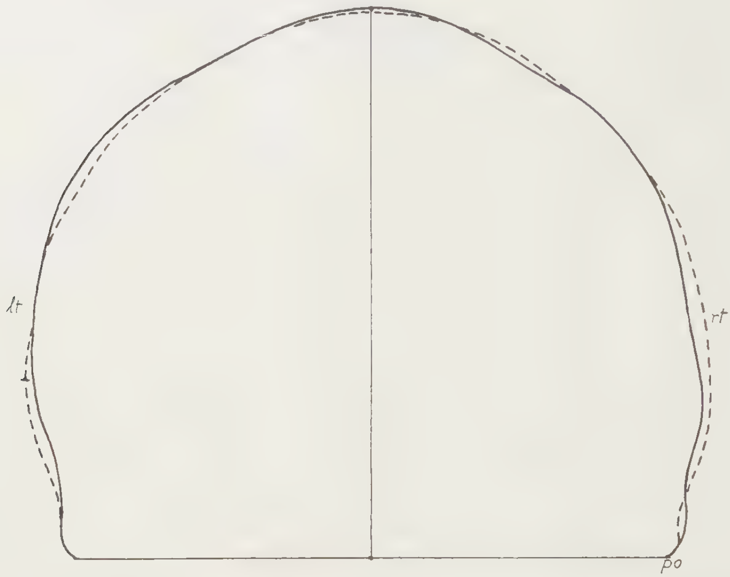

Fig. 2 Transverse interporial diagram of the Keilor skull (——), copied from Wunderly's pl. IX ('43), and the Wadjak skull I (- - -), taken from a cast and corrected, both superimposed on the interporion line (po). × ⅔.

TABLE 2

Main indices of the braincases of the Keilor skull, Wadjak skull I, and the Talgai skull.

INDICES	KEILOR	WADJAK I	TALGAI
Length-breadth	72.6	72.5	73.4
Length-height	72.6	70.1	...
Length-auricular height	60.8	59.0	54.7?
Transverse fronto-parietal	70.6	68.2	70.3
Sagittal cranial curvature	37.8	42.8?	...
Transverse cranial curvature	42.5	41.8?	...

transverse arc of the Wadjak skull cannot be measured with accuracy. The difference between the frontal and the parietal breadth (transverse fronto-parietal index) is minimal, but it indicates again that the Keilor

skull is a little more vaulted in transverse dimension than the Wadjak skull.

Size and form of the two faces are in agreement with the appearance of the braincase. The main measurements are given in table 3 and the upper facial triangle is shown in figure 1. The values of the three angles are listed in table 4. The length of the three sides of the upper facial triangle, that is to say, the length of the cranial base (n-ba), the height of the face (n-pr) and the depth of the face (ba-pr), are practically identical (Keilor skull: 109, 74, 108 mm.; Wadjak skull I: 107, 73, 109 mm.). The angles of the upper facial triangle also differ only to a small extent, but the Keilor skull shows the upper face as being somewhat less prognathous than that of Wadjak skull I, the angle at nasion being 68° in the first case against 71° in the latter.

TABLE 3

Main linear measurements (in mm.) of the faces of the Keilor skull, Wadjak skull I, and the Talgai skull.

MEASUREMENTS	KEILOR	WADJAK I	TALGAI
Upper facial height (n-pr)	74	73	65
Bizygomatic breadth	136	140?	128
Upper facial depth (ba-pr)	108	109	...
Nasion-nasospinale (n-ns)	52	50	...
Nasal breadth	27	30	25
Orbital breadth	39.5	42	40
Orbital height	30	33	32.5
Interorbital breadth	32 (?)	29	29
Maxillary length [1]	61.3	..	...
Maxillary breadth [1]	71.5	71	...
Palatal length [1]	56.5	..	62
Palatal breadth [1]	47.2	..	42

[1] Adam, '43.

TABLE 4

Facial indices and facial angles of the Keilor skull, Wadjak skull I and Talgai skull.

INDICES AND ANGLES	KEILOR	WADJAK I	TALGAI
Upper facial index	54.4	52.1	..
Nasal index	51.9	60.0	61.6
Orbital index	76.0	78.6	81.2
Interorbital index	28.9	25.7	27.3
Maxillo-alveolar index	116.9	..	..
Palatal index	83.6	..	67.7
Upper facial angle at n	68°	71°	..
Upper facial angle at pr	72°	67°	..
Upper facial angle at ba	40°	42°	..

The nasal index (table 4) of the Keilor skull is 51.9, while that of the Wadjak skull is 60. The latter has, therefore, a relatively wider apertura piriformis than the former. The orbital index of the Keilor skull is 76.0 against 78.6 in the Wadjak skull, the latter possessing a somewhat higher orbit than the former. There is also a small difference in the interorbital index: Keilor skull being 28.9, Wadjak skull 25.7. The interorbital breadth, therefore, is relatively greater in the Keilor skull.

The size and form of the maxilla, palate and dental arch are surprisingly similar. Figure 3 illustrates these conditions; the outlines of the Keilor skull (a) are copied from Adams' diagram, that of the

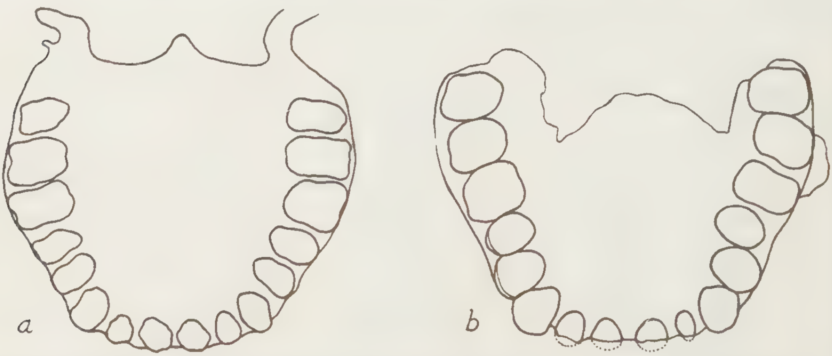

Fig. 3 Palate and upper dental arches of the Keilor skull (a), copied from Adam's figure 1 ('43), and the Wadjak skull II (b), copied from Dubois' figure 6 on pl. II. × ⅜.

Wadjak skull II (b) from a reduced drawing by Dubois. Both copies are in the same proportions. The Wadjak maxilla II is broader than the Keilor maxilla, but both show the horse-shoe shaped outlines with the third molors turning well inwards, as Adams describes the form of the Keilor palate. More important than this agreement in their general form is the fact that the contour in the Wadjak skull curves distinctly inward in the premolar region, while the canines mark the corners and the front teeth are arranged almost in a straight line. The Keilor skull shows exactly the same conditions. As the palate of Wadjak skull I displays the same contraction in the premolar region as Wadjak skull II, this peculiarity cannot be considered as a negligible individual variation but is obviously typical of this hominid form. Its repetition in the case of the Keilor skull is, therefore, all the more indicative.

Regarding the teeth, both skulls have relatively small incisors while the premolars and, particularly, the molars are large. The premolars and molars of the Wadjak skull are larger than those of the Keilor skull as is shown in table 5 which records the size of their rectangles (length × breadth) so far as the figures have been given by Dubois and Adams. We note, not without interest, that in the Keilor skull the second molar is distinctly smaller than the first one, while in the Wadjak skull there is not such a great difference in favor of the first one.

TABLE 5

Size of the upper premolars and molars of the Keilor skull, Wadjak skulls (I and II), and Talgai skull, expressed by the size of their rectangles (length × breadth).

	KEILOR [1]	WADJAK [2]		TALGAI [3]
		I	II	
P^2	75	83	86	88
M^1	148	154	156	162
M^2	129	150	148	150
M^3	116	106	143	...

[1] Adam, '43. [2] Dubois, '22. [3] Smith, '18.

TABLE 6

The amount of differences in three measurements (in mm.) on the heads of twins and the corresponding differences of the Keilor and Wadjak skulls.

MEASUREMENTS	EIGHT TWINS [1]		KEILOR AND WADJAK SKULLS
	Minimum — maximum values	Average	
Difference in maximum length	6 — 12	8.2	3
Difference in maximum breadth	2 — 7	4.6	2
Differnce in auricular height	0 — 5	2.2	2
Difference in horizontal circumference	5 — 27	18.6	1 (?)

[1] Von Verschuer, '25–'26.

The preceding comparison of the Keilor and Wadjak skulls reveals such a conformity in all essential features as may scarcely have ever been found in specimens deriving from such remote places. As a matter of fact the likeness could not be greater if the skulls belonged to identical twins. In order to show how great the differences in the main measurements of the heads of twins can be, I have set side by side in table 6 the figures (minimum-maximum values and average) which I calculated from the eight cases described by von Verschuer ('25–'26) and the cor-

responding differences in the Keilor and Wadjak skulls. The differences in the latter case are indeed far below the average.

The Keilor and the Wadjak individuals are, therefore, without any doubt members of the same human race. Nevertheless, there are some interesting differences. The Wadjak skull has a supraglabellar torus which is absent in the Keilor skull, and its forehead is less vaulted and more sloping. The Wadjak skull is a little lower, its length-height indices being 70.1 and 59.1 against 72.6 and 60.8 in the Keilor skull. The upper face of the Wadjak skull is slightly more prognathous than that of the Keilor skull. The Wadjak teeth are larger; the second molar, in particular, is larger and the difference in size between the first and the second molar is smaller than in the Keilor skull. I also have the impression that the Wadjak skull is heavier and more massive than the Keilor skull. Wunderly does not give any information concerning the thickness of the bones, he confines himself to the remark that the skull is mineralized and very firm. Dubois, too, is tacit about the massiveness of the Wadjak skull; only Pinkley ('36) says: "The most obvious characteristic of the Wadjak skulls is their unusual robustness."

These differences allow for a double interpretation. The Wadjak skull could represent a male individual and the Keilor skull a female of the same race. The other alternative is that the Wadjak skull represents a more primitive stage of evolution. Wunderly considered the Keilor skull as a male because of its resemblance to modern South Australian males. After the experiences I have had in the last years in taking the easier way by explaining these morphological differences as due to sex, I am inclined now to regard them in these cases rather as indications of a different phylogenetic level than as sex differences. The Wadjak skull would represent the more ancient type.

This leads us to a discussion of the geological age of the Keilor skull. According to Mahony the Keilor skull was recovered from a sand pit in a river terrace; this Keilor Terrace, like the Braybrook and Maribyrnong Park Terraces nearby, represents the eustatic rise of the sea level during the Riss-Würm interglacial phase.

"Their heights above sea level correspond to the 40–50 feet raised beaches on northern Tasmania which Edwards correlated with the Riss-Würm interglacial phase." "The skull was found by a worker who was working on the face of the pit when his pick went through the skull and broke it into three pieces. It was about 15 feet below the surface of the ground and 18 inches above the floor of the pit. One fossilized limb bone and several other fragments of bone were found alongside the skull. The sand above the bones showed no signs of having been disturbed by a burial and the skull could not have fallen from above since

it was embedded in undisturbed sand.'' A quartzite flake ''protruding from undisturbed sand in the wall of the pit close to the spot where the skull was unearthed'' . . . is . . . ''evidently an artifact.''

This is the report of the discovery and the conditions of the site where the skull was found. I am not a geologist and know nothing about the river terraces in south Australia and north Tasmania. But I know something about the geology and stratigraphy of the sites from where Sinanthropus and Pithecanthropus come. Furthermore, I am familiar with the difficulties which arise when we try to synchronize these Asiatic sites with the manifold Ice Age horizons in Central Europe so long as little is known about the vast space which separates these two areas from each other. But even if the aforementioned river terraces in northern Tasmania and southeast Australia really took their origin during the last Interglacial Period, there is no evidence that the human bones came into the Keilor sand-pit at exactly the same time that the terrace and the sand were heaped up. The human skeleton may be of old age, but we cannot exclude with absolute certainty that it did not get into the sand long after the terrace was formed. Mahony claims that there were no signs of a disturbance of the sand layers above the bones. But the skeleton or the human body or parts of it may have fallen into the pit many thousand years ago, and if there was a great disturbance at all at that time it could have been completely levelled since then. Sand gives way easily and a relatively small object may sink into it without leaving any trace of the way it got there.

I am, therefore, unable to accept Mahony's assertion of the ''evident'' contemporaneity of the skull and the river terrace, and am astonished that F. Wood Jones ('44) in a review of the new discovery in ''Nature'' accepted Mahony's view without reservation. I contest Wood Jones' statement that ''the Keilor skull is the first Australian human fragment the geological antiquity of which is *definitely guaranteed by the circumstances of its finding*'' (italics mine) and feel concerned about the ease with which he concedes to these questionable geological evidences as furnished in this case. Zeuner ('44) who refers to Wood Jones' review is more cautious. He stresses the important implication of the discovery, namely that Homo sapiens existed in Australia at the time when Homo neanderthalensis lived in Europe, but he adds: ''If the age of the skull as suggested by Mahony can be confirmed.'' This remark can have only one meaning, namely that Zeuner does *not* consider the data of the stratigraphic position of the Keilor skull, so far as they have been presented by Mahony, as sufficient evidence of its great age. In the face of Zeuner's plain reservation it is surprising that Keith

('44) in a short note in which he also points to the significance of the discovery speaks of "Zeuner's confirmation of the great antiquity attributed to the skull by Mahony." This is exactly what Zeuner avoided doing. I am convinced, on the contrary, that the great antiquity (Riss-Würm Interglacial) of the find will not be confirmed, and for this reason I do not see a necessity to speculate for the present on the implications indicated by Wood Jones.[1]

My skepticism, however, should not impair the significance of the discovery. It involves only the geological antiquity claimed for the Keilor skull which I regard as much younger than the Riss-Würm Interglacial. Homo soloensis of Java may belong to this period (H. de Terra, '43). But Homo soloensis is much more primitive than even the European Neanderthalians and morphologically intermediate between Pithecanthropus and the latter (cf. Weidenreich, '43). That at the same time a modern human type like the Keilor Man should have lived in southeast Australia is most improbable. On the other hand, the morphological likeness of the Keilor and Wadjak skulls suggests their contemporaneity. Unfortunately, what we know of the geological age of the Wadjak skulls is very unsatisfactory. The site where, and the conditions under which they were found do not indicate great antiquity. H. de Terra ('43) believes that the Wadjak Man is not much older than the Last Glacial period. Von Koenigswald ('35) even suggests that he may be contemporaneous with the post-Pleistocene fauna from the Sampoeng cave in Central Java, a site from which skeletal remains with Australoid affinities have been described by Mijsberg ('32). De Terra does not agree with such a recent dating of the Wadjak man because he considers him as a morphologically older type. Yet we may come very close to the truth in assigning the Keilor Man, who seems to be more advanced than the Wadjak Man, to the Post-Pleistocene.

New investigations and new discoveries may elucidate this point. But what is already very clear is the fact that a Wadjak type was living very early in southeast Australia. The Wadjak Man was considered by Dubois as a proto-Australian, a view accepted by Keith ('35) without reservation. In my paper on the Sinanthropus skull ('43) I showed that there now is an almost continuous phylogenetic line leading from the Pithecanthropus group through Homo soloensis to the Wadjak Man and from there to the Australian aboriginal of today. This transformation

[1] A. L. Kroeber who reviewed the four papers of the Australian authors in the September issue of this journal (n.s., vol. 2, no. 3, pp. 319–321) shares my doubt about the correctness of their interpretations. He says: "The net effect on the reviewer of the evidence produced in these four important papers is one of scepticism whether Australia has yet yielded anything really ancient either in time or in type of human development."

took place in Java. Whether it was restricted to this island or spread over a larger area we do not know. In any case, if the assumption that the Proto-Australian migrated from Indonesia to the Australian continent is correct, we had to find types like the Wadjak Man, or at least similar to him, in Australia itself. The discovery of the Keilor skull has proved that that theory is correct.

The question whether the Keilor skull combines Australoid and Tasmanoid features and to what extent (on which Wood Jones dwells) is of minor importance as the matter now stands. But it is strange that in the discussion of the morphological characteristics of the Keilor skull neither Wunderly nor Wood Jones made reference to the Talgai skull. It is true that this specimen is badly crushed and the measurements taken by Smith ('18) and others must be used with some reservation. However, a glance at Smith's illustrations and the cast reveals the great resemblance to the Keilor and Wadjak skulls. The Talgai skull is distinctly smaller, but this difference may be partly due to the fact that it belongs to a younger individual, both upper third molars not having erupted yet. The peculiarity of the shape of the palate, which both Keilor and Wadjak skulls show and to which I have referred above, is characteristic also of the Talgai skull. Smith says: "The large incisor teeth are disposed in an almost straight transverse line, the canines jut out prominently at the corners, and the molar-premolar series lie almost parallel, with some slight convergence towards the median plane in the region of the second molar teeth." This statement is correct so far as the arrangement of the incisors and canines are concerned, but it is obviously incorrect in respect to the arrangement of the premolar-molar series, as even a cursory look at Smith's photograph of the original in plate 19, figure 19 shows. These series do not lie "almost parallel" but the undamaged left side exhibits a well developed "horseshoe shaped" curve, the vertex of which coincides with the first molars from where the outline turns again sharply inwards toward the still unerupted third molars. In the premolar region the arch is contracted as it is in the Keilor and Wadjak skulls, as can easily be seen on the right side where the crowns of the premolars are broken off. The only feature in which the Talgai skull disagrees with the Keilor and Wadjak skulls is the deep infraglabellar notch which is characteristic of the modern Australian but is not shown in the Keilor and Wadjak skulls.

The Wadjak people may have immigrated in a very early period into Australia but certainly not before the Last Glacial period; they came from Indonesia where apparently during the entire Pleistocene there were primitive hominids living who gave origin to the Wadjak race.

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THE RELATIONSHIP BETWEEN THE MASCULINE COMPONENT AND PERSONALITY

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INTRODUCTION

This paper deals with the relationship of a body build complex, designated in the Grant Study as the masculine component, to certain traits of personality, behavior, physiological function, etc., in normal young men. The term masculine component refers to the element of masculinity in the individual as indicated by his external morphological features.

It is a matter of common observation that the male body build varies from an angular, rough-surfaced, narrow-hipped, well-muscled, masculine type to the rounder, softer, broader-hipped, less well-muscled feminine type. The anatomical traits here involved are numerous and together may be said to form a composite picture of the degree of masculinity of the individual. The more the pattern of anatomical traits tends toward the extreme masculine form the stronger is the masculine component; the greater the departure from the extreme masculine type towards the more feminine-like build the weaker is the masculine component in the individual. The gradations from the strong masculine component to the very weak masculine component form a continuum. Nevertheless, with the aid of a standardized chart individuals may be readily characterized as having a strong, moderate, weak, or very weak masculine component. Illustrations of the various masculine component categories have been published elsewhere (Seltzer and Brouha, '43· Woods, Brouha and Seltzer, '43).

The morphological traits which indicate deviations from a strongly masculine pattern are easily recognized and have been described in detail by Sheldon ('40) and Draper ('40 and '44). Some of these traits include a general softness and roundness of the body contours and outline, a wider hip line, an approximation of the thighs when heels are together, hyperextensibility of arms and legs, a greater outward curve of the muscular outline of the lower leg in contrast to the flatter inner curve, a well-marked carrying angle at the elbow extending the forearm and hands outwards, a more lateral and "semi-lunar" distribution of

the pubic hair, a greater development of the mammary area, a soft and "velvety" skin, a tendency to small and softened facial features, etc.

It should be emphasized that the traits which mark a departure from the strongly masculine type are not exclusively a matter of adiposity or of poor bone-muscle development. Nevertheless, it does appear that in those individuals who display considerable weakness of the masculine component, the more frequent is the association with strong endomorphy and often with weak mesomorphy.

The assignment of an individual to any specific masculine component gradation should be based on the overall approximation of the individual to the pattern of the category. However, because of the essential continuity of the degrees of development of the masculine component in the male population, it is to be expected that some instances will be encountered where the overall pattern of the individual does not exactly correspond to what is typical for either of two masculine component categories, but represents a condition intermediate between them. In such an instance, when the individual, for example, appears to have a greater weakness of the masculine component than may be typical for the moderate category but yet not so weak in the masculine component to be typical for the weak category, he can be designated as being moderate-weak in the masculine component. Other intermediate designations are thus strong-moderate, and weak-very weak. It is believed, by this method if the situation warrants, sufficient flexibility is contained in the four-fold categorization to serve adequately the purposes for which it was designed.

The use of this masculine component terminology does not preclude the aspect of the gynic (feminine) factor in males. Since we do not actually know what the morphological deviations are due to, the point of view taken here is that deviations from the strongly masculine pattern, whether due to variations in andric (masculine), gynic (feminine) or other factors, are regarded as weakness of the masculine component. It is hoped that in the near future positive endocrinological evidence will be available which will enable us to identify the endocrinological relationships of the morphological traits under consideration.

The proportion of individuals in the population with weakness of the masculine component is highly variable and apparently dependent on the occupational nature and selection of the group.[1] Weakness of the masculine component occurs in about 15% of the general population, based on a survey of approximately 1800 young men who pre-

[1] Hereafter the term "weakness of the masculine component" will refer to those individuals classified as moderate, weak, very weak, as well as their intermediate categories.

sented themselves for medical examination at an Army induction center. On the other hand, weakness of the masculine component was found in only 6% of a large series of air cadets, while it ran as high as 20% in communication officers, and even to 26% in chaplains.[2]

THE MATERIAL

The material on which this study is based has been drawn for the most part from the data of the Grant Study at Harvard University. The nature of the Grant Study research affords an unusual opportunity for the examination and comparison of the characteristics of normal young men with weakness of the masculine component.[3] The presence of a variety of data from other disciplines in addition to the anthropological, makes it possible to relate this physical attribute to various component parts of the total personality.

Masculine component ratings of the individuals in the Grant Study series made after careful inspection of the subjects in the nude, revealed the fact that 27 out of a total of 258 or 10% of individuals possessed clear evidence of weakness of the masculine component. Table 1 gives the frequency of the masculine component ratings for this group. Since the number of individuals in the separate categories is so small

TABLE 1

Ratings of the Grant Study subjects with weakness of the masculine component.

	NUMBER
Moderate	14
Moderate-weak	3
Weak	8
Weak-very weak	1
Very weak	1
	27

it was deemed advisable, for the purpose of this paper, to consider the group as a whole. It is recognized, of course, that such a procedure does not allow for the recognition of different degrees of weakness of the masculine component, nor of the variation in basic body build structures. Consideration of these important factors, as well as others, must necessarily await the accumulation of a much larger series than that at hand. All that can be reasonably expected from the analysis of these data is the appearance of generalized overall patterns of differentiation which may distinguish individuals with weakness of the masculine component as a group.

[2] It is interesting to note in this connection that Terman and Miles ('36) found very low masculinity-feminity (M-F) scores (i.e., relative approach to feminine) for groups of clergymen and theological students.

[3] For a brief description of the work of the Grant Study see F. L. Wells ('44) and Clark W. Heath, et al. ('45).

MASCULINE COMPONENT AND PERSONALITY TRAITS

Personality evaluations of the Grant Study subjects were independently made by the staff psychiatrists. A detailed account of their methods of interview and personality classification will be published soon. For the purposes of this study special attention has been directed to the classification of the subjects according to personality trait groupings. These personality trait groupings were derived from the mass of psychiatric material collected on the subjects studied. The recurrent appearance of certain personality traits with considerable frequency made it desirable to place in groups those subjects who had specific *outstanding* characterisitics in common. Thus, for example, there appeared a shy group, an unstable autonomic functions group, a vital affect group, a pragmatic group, an ideational group, a sociable group, a self-conscious introspective group, etc. These various trait groupings were assigned to an individual with no consideration of the other traits which might pertain to him.

Affect. In the realm of personality affect it is found that the Grant Study subjects with weakness in the masculine component have a deficiency of their members in the vital affect category compared with the individuals with strong masculine component. Only 2 out of 27 or 7% of the subjects with weakness of the masculine components fall into the vital affect group against 49 or 22% of the 226 individuals with strong masculine component. The vital affect grouping according to the definition of the psychiatrist consists of a group of young men "characterized by vitality and richness of affect. They show a spontaneous force and energy which springs from strong affect rather than from energy, determination and perseverance which depends upon the voluntary effort of the higher ego functions . . . "

There is very little difference between the individuals with strong masculine component and those with weakness of the masculine component in their frequency of representation in the bland affect grouping, but in the sensitive affect grouping the individuals with weakness of the masculine component have a far larger proportion of their number than do the strong masculine category. Thirty-seven per cent of the subjects with weakness of the masculine component fall into the sensitive affect grouping compared to only 16% for the strong masculine component group. The sensitive affect grouping is defined as "a group characterized by sensitive affect which prevades the whole personality and which frequently shows itself in the social sphere of shyness. They are subtle in their thinking, inclined to be aesthetic and to place greater emphasis on cultural values . . . "

Mood. There are no apparent differences between the strong masculine component group and those with weakness of the masculine component in mood level.

Autonomic functions. The Grant Study subjects with weakness of the masculine component are found more frequently in the unstable autonomic functions designation, this trait occurring in 26% of the individuals with weakness in the masculine component .compared to 13% for those subjects rated as strong in the masculine component. The unstable automonic functions grouping includes those "who show manifestations of instability in the functions which are generally conceded to be related to the autonomic nervous system. Included are boys who show either periodic excessive anxiety or an undue amount of chronic anxiety as well as those subject to such symptoms as tremulousness, blushing, increased perspiration, palpitation . . . "

Basic personality. At the basic personality level the individuals with weakness of the masculine component have only slightly smaller representation (52%) in the well-integrated personality grouping than do the strong masculine component subjects (61%). However, it is in the less well-integrated personality grouping that they show considerable differentiation. In this latter grouping are found 26% of the individuals with weakness of the masculine component against 14% for the strong masculine category. The less well-integrated grouping consists of boys "who in contrast to those of well-integrated personality, are erratic, unreliable, sporadic or undependable . . . "

Motivations. The individuals with weakness of the masculine component are somewhat less well-represented than those with strong masculine component in the physical science grouping. In this grouping are boys "who have exhibited a predominant interest in physical phenomena. They frequently describe early mechanical interests and aptitudes, preference for scientific subjects in secondary school, and a liking for the manipulations of laboratory work. . . . " Only 7% of the Grant Study subjects with weakness of the masculine component are found in the motivations towards physical science grouping against 13% for the strong masculine category.

The individuals with weakness of the masculine component have slightly fewer of their numbers than the strong masculine class in the practical organizing grouping, but exhibit large excesses in the ideational and creative and intuitive groupings. In contrast to the strong masculine component category, the individuals with weakness of the masculine component have 33% of their numbers in the ideational grouping against 20% ; again 18% against 5% in the case of the creative and

intuitive grouping. The ideational grouping contains "young men who like to deal with ideas and tend to shy away from routine work and problems of practical life. They tend to be theoretical or analytical. Many of these with high verbal ability are found among this group, and those who are interested in scholarship, literary criticism, philosophy, and social problems. . . . " The creative and intuitive grouping is "characterized by high ability for self-expression or who are original and creative in their thought. Included are those who are strongly intuitive and spurn logical, objective and analytical forms of thought . . ."

Social traits. The individuals with weakness of the masculine component are somewhat in excess of the strong masculine component subjects in the shy grouping, strongly in excess in the asocial grouping, and less frequently represented in the sociable grouping. The percentages for the individuals with weakness of the masculine component and the strong masculine component category are 33% and 25% respectively for the shy grouping, 22% and 8% for the asocial grouping, and 15% and 23% for the sociable grouping.

The shy grouping consists of those individuals who "experience a high degree of tension in social situations, and are embarrassed, reserved, and awkward in manner. There is a fundamental liking for people and a regret that shyness leads them to avoid social events which they would enjoy if they could feel natural. A sense of social insecurity and lack of confidence is frequently described . . . " The asocial grouping contains those young men "for whom social life, intimate friendships, and an interest in people is relatively unimportant. Such young men are satisfied with their own company and in the extreme are considered lone wolves' . . . Unlike the shy group, they have not an unexpressed liking for people and yearning for social life." The sociable grouping "are naturally friendly and who like to do things with people. Social activities may be their outstanding interest. They make friends easily, like to meet new people, and have an ease in their social relationships which is unhampered by shyness or awkwardness."

Purposive and controlled functions. There is very little difference between the individuals with weakness of the masculine component and the strong masculine category in their representation in the self-driving grouping, but with respect to the self-conscious and inhibited groupings important divergencies appear. In the self-conscious grouping, the indivduals with weakness of the masculine component have a frequency of 37% compared to 23% for the strong masculine component class, and similarly 37% and 17% in the case of the inhibited grouping.

The self-conscious grouping is defined as "a group of individuals who are highly aware of their own thoughts and subjective feelings. They tend to pay much more attention to what is going on within themselves than do more natural and out-going boys . . ." The inhibited grouping contains "a group who have a strong degree of conscientiousness and who frequently have conflicts about doing things which they intellectually condone . . . A lack of spontaneity and freedom and a degree of stiffness in manner are characteristic. They are very apt to have conflicts about their course in life and to vacillate in their decisions . . . More important is the discrepancy between spontaneous desires and what is thought to 'be right.' "

Attitudes. In comparison with the strong masculine group, the individuals with weakness of the masculine component fall more frequently into the cultural and lack of purpose or values groupings, but less frequently in the political, humanistic and pragmatic groupings. The differences are most marked in the case of the cultural, humanistic and pragmatic traits.

The cultural grouping contains boys "for whom enjoyment of participation in literature or arts is predominant. This interest may be so highly developed that it leads them either to follow an artisitic career or to consider any form of life work as a means of existence in order that they may satisfy their cultural needs." In the humanistic grouping are those "who have dominant interest in people and for whom a knowledge of people and a desire to do a kind of work which will bring them into contact with people is not only an outstanding feature of their personality but also the strongest driving force in determining their choice of life work." And finally, the pragmatic grouping consists of those "who are essentially practical in outlook and are not concerned with the ultimate purpose and value of life. They are apt to be conforming and conventional, and they accept the mores of the times . . . The practical considerations of getting ahead in life outweigh intrinsic interest in work, cultural values, philosophical speculations, or special reform."

Table 2 summarizes the comparison of the individuals showing weakness of the masculine component and those of the strong masculine category, with respect to the various personality trait groupings. The data are so arranged that the personality traits are grouped together according to whether their frequencies in the weakness of the masculine component category show an excess or deficiency over the individuals with strong masculine component. It is clear from this table that the individuals with weakness of the masculine component are more in-

clined to possess such traits as shyness, sensitivity, self-consciousness, inhibition, creativeness, and the like. With hardly an exception the groupngs in which the individuals with weakness of the masculine component dominate the strong masculine category may be said to form a consistent pattern or syndrome of traits. This is very striking in view of the small size of the group with weakness of the masculine component, and serves to support the findings. The trait groupings in which

TABLE 2

Masculine component and personality trait groupings.

Personality trait groupings	Individuals with strong masculine component (226)		Individuals with weakness in masculine component (27)		Trend of differences
	No.	%	*No.*	%	
Sensitive affect	35	15.5	10	37.0	+
Unstable autonomic functions	29	12.8	7	25.9	+
Less well-integrated personality	31	13.7	7	25.9	+
Ideational	45	19.9	9	33.3	+
Creative and intuitive	11	4.9	5	18.5	+
Shy	57	25.2	9	33.3	+
Asocial	18	8.0	6	22.2	+
Self-driving	31	13.7	5	18.5	+
Self conscious	53	23.5	10	37.0	+
Inhibited	39	17.3	10	37.0	+
Cultural	42	18.6	12	44.4	+
Lack of purpose or values	48	21.2	7	25.9	+
Vital affect	49	21.7	2	7.4	—
Bland affect	41	18.1	4	14.8	—
Well-integrated personality	138	61.1	14	51.8	—
Physical science	29	12.8	2	7.4	—
Practical organizing	86	38.1	8	29.6	—
Sociable	51	22.6	4	14.8	—
Political	41	18.1	3	11.1	—
Humanistic	38	16.8	2	7.4	—
Pragmatic	92	40.7	7	25.9	—

the strong masculine type dominate are the stronger and more vital personality traits such as the humanistic, the sociable, the pragmatic, the vital affect. With the exception of the bland affect grouping, again we find a consistent pattern of traits.

The figures presented tell the story in terms of individual personality trait groupings taken separately. Accordingly, in view of the small size of the series, the possibility exists that the more sensitive and complex traits may be concentrated in a relatively small number of the individuals with weakness of the masculine component and thereby presenting

a spurious result. That this condition does not apply here is shown by the fact that at least one of the list of weak and sensitive personality traits occurs in 25 out of 27 or 93% of the individuals with weakness of the masculine component and in only 69% of the strong masculine variety. At least two of the list of weak and sensitive personality groupings occur in 22 out of 27 or 81% of the individuals with weakness of the masculine component compared to 45% of the strong masculine variety.

In evaluating these associations between the masculine component and personality traits, it must be borne in mind that no differentiation has been made with regard to the basic body build types or primary structural components of the subjects. Since personality is seen as influenced by the combination of the masculine component and the basic body build patterns, the importance of the latter must not be minimized. In the group of individuals presented here with weakness of the masculine components, there is a wide range of body build patterns.[4] Unfortunately, the relatively small size of the series involved does not allow for a satisfactory statistical assessment of the interaction of these elements.

Further evidence of a relationship between the masculine component and personality has been presented elsewhere (Woods, Brouha and Seltzer, '43). This concerned the question of leadership qualities. As a result of a study of a large number of Army and Navy R.O.T.C. students at Harvard College who were rated independently by their officers, it was found that leadership qualities of the nature required of combat officers were noticeably lacking in individuals with weakness of the masculine component. In the group with strong masculine component 41% were rated as excellent officer candidates, the rest being equally divided between satisfactory, doubtful or poor. The group with moderate masculine component contained only 11% of students who were rated as excellent officer candidates, 37% who were rated as satisfactory, and 53% as doubtful or poor risks. Of the group with weak and very weak masculine component there were no individuals who received an excellent officer rating, only 23% were regarded as satis-

[4] According to the Sheldonian classification, the most frequent somatotypes in this group are the endomorphic mesomorphs, and the balanced variety. Next in order of frequency are the endomorphic ectomorphs, and the strong endomorphs. The remaining are scattered examples of mesomorphic ectomorphs, strong and moderate mesomorphs, moderate ectomorphs, ectomorphic mesomorphs, etc.

Since this study deals with a selected group of normal young men, who are inclined towards mesomorphy, there is probably more mesomorphy with weakness of the masculine component than one would expect to find in the general population.

factory and 77% who were considered doubtful or poor officer candidates.[5]

In the realm of formal intellectual functions, academic interest and career choice, it is found that the individuals with weakness of the masculine component are in many ways unlike those with strong masculine component (table 3). In the matter of verbal functions insofar as these are covered by tests of the multiple choice type, the individuals with weakness of the masculine component tend to be somewhat higher than the strong masculine variety. In the Alpha Verbal test the mean difference is 8 points higher (critical ratio 3.94) in favor of the group with weakness of the masculine component, and in the Scholastic Aptitude Test 29.60 points higher (critical ratio 5.50). In the mathematical or number functions, the individuals with weakness of the masculine component are somewhat lower in test scores than the strong masculine type, but not significantly so. The mean differences in the case of the Alpha Number test is 6.10 points (critical ratio 2.12) and for the Mathematical Attainments Test 33.30 units (critical ratio 2.24). However, in the difference between Alpha Verbal and Alpha Number the group with weakness of the masculine component display much larger discrepancies in favor of the Alpha Verbal than do the strong masculine type. The mean difference between the two groups is 13.80 and the critical ratio 5.50.

In tests of the block assembly type and in number of Rorschach responses, no differences of special significance appear between the two masculine component groups.

Academically, the fields of concentration of the individuals with weakness of the masculine component fall very heavily in the area of arts, letters, and philosophy in contrast to the areas of social studies and natural sciences. The latter, particularly the area of natural sciences, is seldom chosen by the less masculine person as an academic major. All this is naturally reflected in their plans for the future with respect to choice of career. This is clearly illustrated by the proportion of individuals who have selected business as their life work. Although 22% of individuals of a sample of 150 Grant Study subjects studied for question of career choice, have definitely indicated their intention

[5] This is based on a total of 632 cases. The correlation of the masculine component with the Army officer ratings has been computed by others interested in this material to be 0.55 based on the average of four tetrachoric r's. Two dichotomies were used for the masculine component, one between strong and moderate, and the second between moderate and weak. Also, two dichotomies were used for the Army rating, once between B+ and B, and again between B— and C+. This procedure gave four tetrachoric correlations: 0.54, 0.48, 0.55, and 0.65. The average of these tetrachorics was 0.55.

TABLE 3

Masculine component and psychometric test scores.

		NO.	RANGE	MEAN	P. E.	S. D.	COMPARISON OF MEANS DIFF.	P. E.	CRITICAL RATIO
Alpha Verbal — Total	Strong masculine comp.	165	118–212	181.50 ±	.93	17.75	+ 8.00 ±	2.03	3.94
	Weakness in masculine comp.	24	160–208	189.50 ±	1.81	13.15			
A-V — Test B	Strong masculine comp.	165	19– 40	33.10 ±	.24	4.64	+ 1.32 ±	.58	2.28
	Weakness in masculine comp.	24	26– 40	34.42 ±	.53	3.85			
A-V — Test C	Strong masculine comp.	165	21– 40	36.07 ±	.23	4.33	+ 0.85 ±	.48	1.77
	Weakness in masculine comp.	24	29– 40	36.92 ±	.42	3.07			
A-V — Test D	Strong masculine comp.	165	21– 40	33.62 ±	.23	4.44	+ 1.88 ±	.48	3.92
	Weakness in masculine comp.	24	28– 40	35.50 ±	.42	3.07			
A-V — Test G	Strong masculine comp.	165	8– 24	20.33 ±	.18	3.49	+ 1.96 ±	.45	4.36
	Weakness in masculine comp.	24	16– 32	22.29 ±	.41	2.98			
Alpha Number — Total	Strong masculine comp.	165	94–205	164.15 ±	1.13	21.45	— 6.10 ±	2.87	2.12
	Weakness in masculine comp.	24	128–209	158.05 ±	2.64	19.15			
A-N — Test A	Strong masculine comp.	165	8– 19	13.95 ±	.12	2.33	— 0.53 ±	.36	1.47
	Weakness in masculine comp.	24	8– 20	13.42 ±	.34	2.46			
A-N — Test E	Strong masculine comp.	165	5– 12	10.45 ±	.07	1.25	— 0.20 ±	.20	1.00
	Weakness in masculine comp.	24	8– 12	10.25 ±	.20	1.42			
A-N — Test F	Strong masculine comp.	165	5– 16	12.87 ±	.14	2.69	— 0.75 ±	.32	2.34
	Weakness in masculine comp.	24	9– 16	12.12 ±	.29	2.09			
A-N — Test H	Strong masculine comp.	165	9– 20	15.30 ±	.14	2.73	— 0.38 ±	.36	1.06
	Weakness in masculine comp.	24	11– 20	14.92 ±	.33	2.41			
Diff. AV-AN	Strong masculine comp.	165	(—36)–(+77)	17.80 ±	1.05	20.00	+13.80 ±	2.51	5.50
	Weakness in masculine comp.	24	(— 7)–(+61)	31.60 ±	2.28	16.55			
S.A.T.	Strong masculine comp.	165	363–777	599.10 ±	4.04	77.00	+29.60 ±	12.96	2.28
	Weakness in masculine comp.	24	500–793	628.70 ±	12.31	89.40			
M.A.T.	Strong masculine comp.	133	234–803	583.30 ±	5.62	96.00	—33.30 ±	14.85	2.24
	Weakness in masculine comp.	19	414–743	550.00 ±	13.74	88.00			
Condensed Rorschach Response number	Strong masculine comp.	170	8– 55	26.02 ±	.49	9.46	— 1.34 ±	1.51	0.89
	Weakness in masculine comp.	21	12– 49	24.68 ±	1.43	9.72			

to go into business for their life work, only 6% of the individuals of the less masculine type have this kind of occupation in mind. They tend to choose careers like teaching, fine arts, government, and the ministry. Table 4 shows how the individuals with weakness of the masculine component distribute themselves with regard to fields of concentration.

TABLE 4

Masculine component and fields of concentration.

	INDIVIDUALS WITH STRONG MASCULINE COMPONENT		INDIVIDUALS WITH WEAKNESS IN MASCULINE COMPONENT	
	No.	%	*No.*	%
Area of natural sciences	76	32.9	3	11.1
Area of social studies	95	41.1	8	29.6
Area of arts, letters and philosophy	60	26.0	16	59.3
	231	100.0	27	100.0

The small size of the series of individuals with weakness of the masculine component makes it difficult to assess factors of a socio-economic nature. However, the available data fail to indicate any significant differentiations between the individuals with weakness of the masculine component and the strong masculine type with regard to such factors as home residence, financial conditions of the parents, per capita income within the family, familial culture grouping, size of family, sibling positions, religious affiliation, highest schooling of parents, etc. There was a slight excess, however, of "only children" among the group with weakness of the masculine component. As far as type of preparatory schooling is concerned the individuals with weakness of the masculine component did seem to show a slight excess of their number who had had private schooling, and a deficiency of individuals who had attended both public and private schools prior to their entrance to college.

MASCULINE COMPONENT AND PHYSICAL ACTIVITY

If we turn to the field of general physical efficiency and athletics, it is found that the less masculine variety of individuals fail to exhibit the usual interest and ability in athletics that is found among the more masculine types. They are on the whole disinclined to exercise and to participate in sports in general. From the data in table 5 it may be seen that the individuals with weakness of the masculine component show a noticeable failure of participation in the more violent contact sports such as football, boxing, hockey, basketball, baseball, wrestling,

and soccer. Their participation in sports seems to lie in the direction of the more individual non-contact type of exercise such as sculling, tennis, swimming, gym work, squash, and golf. There is no doubt that this is in part due to their lower state of physical fitness for hard muscular work and their inability to compete successfully with their more masculine brethren.

TABLE 5

Masculine component and sports in college.

	INDIVIDUALS WITH STRONG MASCULINE COMPONENT		INDIVIDUALS WITH WEAKNESS IN MASCULINE COMPONENT	
	No.	%	*No.*	%
1. Group contact sports (football. baseball, basketball, hockey)	46	19.9	2	7.4
2. Minor group sports (soccer, lacrosse, polo)	10	4.3	1	3.7
3. Individual contact sports (boxing, wrestling, fencing)	14	6.1	0	0.0
4. Non-contact sports (crew, rowing, track, tennis, swimming, gym, walking, squash	151	65.4	23	85.2
5. No sports	10	4.3	1	3.7
	231	100.0	27	100.0

[1] The "no sports" group include in part individuals who claim they lack sufficient time in their program for athletic participation.

This matter of lower physical fitness [6] of the individuals with weakness of the masculine component has been demonstrated already in studies made on large groups of college students as well as sizeable numbers of men in the armed forces (Seltzer and Brouha, '43). In every sample investigated the individuals with weakness of the masculine component are inferior in physical fitness to the strong masculine type. Furthermore, the less masculine the physique the poorer is the level of physical fitness. Even after prolonged training and physical conditioning the less masculine group of individuals do not quite reach the same state of physical efficiency as shown by the more masculine type. In no instance do the individuals with weakness of the masculine component reach the high peak of physical fitness such as is found in varsity athletes in training.

[6] The term physical fitness in this paper refers to the functional or dynamic fitness of the individual with respect to the ability to do strenuous muscular work. (Gallagher and Brooha, '43).

DISCUSSION AND CONCLUSION

The preceding observations appear to indicate the existence of an association between the masculine component and certain other aspects of the total personality of the individual. Considered as a group, the individuals with weakness of the masculine component exhibit a characteristic pattern of traits which form a consistent and harmonious picture. Briefly summarized, these less masculine persons may be described as having, in general, an aversion to strenuous exercise and sports, particularly those involving bodily contact. They are apt to be low in physical fitness for hard muscular work and often poor in muscular coordination. In the realm of personality structure, they present an affect which is more frequently sensitive and seldom the type which is described as "vital." In the autonomic functions, they show a strong tendency to possess manifestations of instability in the functions which are dependent on the vegetative nervous system. At the level of the basic personality they appear to present higher frequency of cases of individuals whose personality structures are "less-well integrated." With respect to the question of motivations, they are inclined towards "ideational" and "creative and intuitive" traits, while showing an infrequency of "practical organizing" and "physical science" characteristics. In social traits, they are apt to be more frequently "shy" and "asocial," and in the purposive and controlled functions "self-conscious" and "inhibited." At the attitude level, they fall more frequently in the "cultural" grouping and are less prone to the "humanistic" and "pragmatic" traits than the strongly masculine category.

Leadership qualities of the type required for combat officership is noticeably lacking in individuals with weakness of the masculine component. The less masculine the physique the more deficient are the individuals in these leadership qualities.

In the more formal intellectual functions, the group of individuals with weakness of the masculine component tend to be higher in the verbal functions and possibly lower in the mathematical or number functions. A greater difference is found among them with respect to the individual discrepancy between the verbal and number functions. Academically, they most often select the area of arts, letters, and philosophy as a field of concentration, and their choice of career is most apt to follow this same line of interest. No differences of any special significance appear between the group of individuals with weakness of the masculine component and those classified as strong when contrasted for a number of features of a socio-economic nature.

In evaluating these results, it is well to bear in mind that this study is to be considered in the light of a preliminary excursion into this interesting and highly provocative field. The author is aware of the limitations of the material presented here and of the existence of a number of factors impinging on this problem which require investigation. The size of the populations studied, the selected nature of the samples, the question of the varying degrees of weakness of the masculine component, the influence of the varying basic body build patterns underlying the masculine component factor, the nature of the complex of personality manifestations found in these individuals, social and cultural factors, are a few of the pertinent considerations which must be studied. The character of the results presented, however, are highly suggestive and make further study of this problem a potentially fruitful source of information concerning the role of the physical constitution in the total personality of the individual.

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PLURAL BIRTH FREQUENCIES IN THE TOTAL, THE "WHITE" AND THE "COLORED" U. S. POPULATIONS[1]

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It is surprising to find an almost complete lack of readily available and analyzed U. S. plural birth data. The most frequently quoted figures are those which were presented by Nichols in 1907. Now it is true that these data were published in a U. S. journal, The American Anthropological Association Memoirs, but upon examination of the original source it is found that these data are almost entirely European. Hamlett and others have presented some U. S. percentages, but these are not extensive and are not treated statistically. The U. S. census reports contain, of course, most of the information that is wanted but it is not summarized in the desired form and it is not analyzed. In this paper we have brought together from census reports the twin, triplet and quadruplet birth frequencies of the total, the "white", and the "colored" population of the U. S. Birth Registration Area from 1922 to 1936 inclusive, and have subjected these data to certain statistical treatments. The year 1922 was chosen as the first year to be included because census data from previous years are not complete with respect to the information wanted. 1936 was chosen as a convenient concluding year because it marks the end of a particular series of census publications. Later census birth data are more detailed, but they are not extensive enough as yet for analysis.

From an inspection of table 1 it will be seen that the twin confinement frequency of the total U. S. Birth Registration Area for the 15-year period under consideration is 1.161%. This percentage agrees closely with the usually quoted figure of 1 twin confinement in every 86. Actually the observed is equal to 1 in 86.13. The triplet confinement frequency is .01189% which is equal to about 1 in every 8,411; and the quadruplet confinement frequency is .000203% which is equal to about 1 in every 492,314. No quintuplet or sextuplet births were reported for the U. S. Registration Area during the interval included in this study.

[1] The author wishes to express his appreciation to Prof. Sewall Wright for suggestions and criticisms.

Of interest is the regularity with which plural births of the different types occur from year to year. For example the twin confinement frequency for any given year during the 15-year interval examined does not rise above 1.189% and does not fall below 1.117. This can only mean that the environmental and/or the genetic factors which are responsible for twinning are fairly constant. The extent to which they are constant can best be expressed in terms of the variance of the observed

TABLE 1

Total (i.e. all single and plural), twin, triplet and quadruplet confinement frequencies in the U. S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	TOTAL	TWIN No.	TWIN %	TRIPLET No.	TRIPLET %	QUADRUPLET No.	QUADRUPLET %
1922	1,823,306	21,173	1.161	215	.01179	4	.000219
1923	1,840,558	21,454	1.166	191	.01038	3	.000163
1924	1,983,162	22,763	1.148	247	.01245	4	.000202
1925	1,928,356	21,536	1.117	246	.01276	5	.000259
1926	1,904,624	21,747	1.142	202	.01060	3	.000158
1927	2,194,487	25,756	1.174	253	.01153	6	.000273
1928	2,295,501	26,794	1.167	305	.01329	3	.000131
1929	2,228,571	26,494	1.189	262	.01176	3	.000135
1930	2,263,723	26,130	1.154	275	.01215	7	.000309
1931	2,167,781	25,083	1.157	253	.01167	2	.000092
1932	2,126,778	25,089	1.180	254	.01194	6	.000282
1933	2,132,809	24,999	1.172	234	.01097	5	.000234
1934	2,219,577	26,012	1.172	266	.01198	6	.000270
1935	2,206,514	25,218	1.143	246	.01115	0	.000000
1936	2,192,327	25,583	1.167	297	.01355	7	.000319
Total	31,508,074	365,831	17.409	3746	.17798	64	.003046
Mean	2,100,538	24,389	1.161	250	.01187	4.3	.000203

percentage frequencies. For the twin percentage frequencies of the total population the observed variance,

$$\sigma_0^2 = \frac{\Sigma f d^2}{N - 1} = \frac{.000,000,450,8}{14} = .000,000,032$$

Considered by itself a variance value is of little interest but it is an extremely useful statistic for comparative purposes. One of the questions which might be asked with respect to the multiple birth data is this, does the mean observed twin percentage frequency vary significantly more than might be expected on a basis of chance? The variance of a percentage expected on a basis of chance (σ_T^2) is given by the formula $\frac{p \cdot q}{N}$, where p and q are the percentage frequencies, and N is the

number of individuals involved. For the mean twin percentage frequency of the U. S. Birth Registration Area from 1922 to 1936 inclusive

$$\sigma_T^2 = \frac{.98839 \times .01161}{2{,}100{,}538} = .000{,}000{,}005{,}46$$

If we compare this variance with the observed variance for the 15-year interval we find that it is 5.9 times smaller. Fisher has furnished us with a statistic which he has called F which gives us the probability of getting one variance a certain number of times greater or smaller than another. Snedecor has provided us with a table which gives the probabilities of F values. From Snedecor's tables we find that an F value of 1.69 with 14 degrees of freedom for the larger variance and an infinite number of degrees of freedom for the other has a probability of .05 and an F value of 2.07 has a probability of .01. Since the obtained F value is 5.9, and therefore much greater than the F value with a probability of .01, we may conclude that the yearly twin percentages of the total population vary considerably more than might be expected due to chance. This is true even if we calculate the variance due to chance by using the p and q of the total population but use the N of each year and divide by 15. What the factors are which cause the yearly twin percentages to vary more than might be expected on a basis of chance is not evident. It may be due in part to the proportionately greater contribution of the "colored" population to the Birth Registration data in later years. As we shall show presently this group has a significantly higher twin percentage frequency than does the "white".

The observed variances of the triplet and quadruplet percentages for the total population during the interval indicated do not differ significantly from those expected due to chance.

From a genetic point of view it is of special interest to separate the total U. S. population into as many genetic subgroups as possible and to compare the plural birth frequencies of the different ones. Unfortunately the census data do not permit any extensive separation. The only subdivision that can be made is the bifurcation of the total population into "white" and "colored". The "white" group represents in general only the Caucasoid stock. The "colored" group, however, is a mixture of Negroid, Mongoloid, and probably some Caucasoid stock, but with Negroes contributing in all years well above 90%.

The "white" and the "colored" plural percentage frequencies are given in tables 2 and 3 respectively. The variance of the twin percentage frequencies of the "white" group is considerably greater than that expected on a basis of chance. ($F = 3.9$); that for the "colored" group,

TABLE 2

"White" total, twin, triplet and quadruplet confinement frequencies in the U. S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	TOTAL	TWIN No.	TWIN %	TRIPLET No.	TRIPLET %	QUADRUPLET No.	QUADRUPLET %
1922	1,669,372	18,956	1.136	188	.01126	4	.000240
1923	1,683,642	19,150	1.137	161	.00956	3	.000178
1924	1,805,178	20,274	1.123	220	.01219	3	.000166
1925	1,772,524	19,465	1.098	215	.01213	4	.000226
1926	1,746,907	19,602	1.122	179	.01025	3	.000172
1927	1,969,630	22,585	1.147	207	.01050	4	.000203
1928	2,028,004	23,058	1.137	246	.01213	3	.000148
1929	1,967,521	22,652	1.151	210	.01067	2	.000102
1930	1,990,485	22,124	1.111	218	.01095	5	.000251
1931	1,888,501	21,108	1.118	199	.01054	2	.000106
1932	1,842,699	21,062	1.143	208	.01129	6	.000326
1933	1,831,520	20,746	1.133	172	.00939	3	.000164
1934	1,902,624	21,605	1.136	202	.01062	4	.000210
1935	1,925,094	21,297	1.106	194	.01008	0	.000000
1936	1,915,914	21,668	1.131	224	.01169	3	.000157
Total	27,939,615	315,352	16.929	3043	.16326	49	.002649
Mean	1,862,641	21,023	1.129	202.87	.01088	3.27	.000177

TABLE 3

"Colored" total, twin, triplet and quadruplet confinement frequencies in the U. S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	TOTAL	TWIN No.	TWIN %	TRIPLET No.	TRIPLET %	QUADRUPLET No.	QUADRUPLET %
1922	153,934	2,217	1.440	27	.01754	0	.000000
1923	156,916	2,304	1.468	30	.01912	0	.000000
1924	177,984	2,489	1.398	27	.01517	1	.000562
1925	155,832	2,071	1.329	31	.01989	1	.000642
1926	157,717	2,145	1.360	23	.01458	0	.000000
1927	224,857	3,171	1.410	46	.02046	2	.000889
1928	267,497	3,736	1.397	59	.02206	0	.000000
1929	261,050	3,842	1.472	52	.01992	1	.000383
1930	273,238	4,006	1.466	57	.02086	2	.000732
1931	279,280	3,975	1.423	54	.01934	0	.000000
1932	284,079	4,027	1.418	46	.01619	0	.000000
1933	301,289	4,253	1.412	62	.02058	2	.000664
1934	316,953	4,407	1.390	64	.02019	2	.000631
1935	281,420	3,921	1.393	52	.01848	0	.000000
1936	276,413	3,915	1.416	73	.02641	4	.001447
Total	3,568,459	50,479	21.192	703	.29079	15	.005950
Mean	237,897	3,365	1.413	46.87	.01939	1	.000397

is also slightly outside the expected range (F = 2.6). The variance of the triplet percentage frequencies of neither the "white" nor the "colored" group is outside the range expected by chance but that for "white" quadruplets is.

To test for the significance of the difference of the means of the "white" and the "colored" plural birth frequencies the following formula was applied:

$$t = \frac{\Delta}{\sqrt{\frac{\Sigma (X_1 - \overline{X}_1)^2 + \Sigma (X_2 - \overline{X}_2)^2}{N_1 + N_2 - 2} \times \frac{N_1 + N_2}{N_1 N_2}}}$$

The t values which were obtained are presented in table 4. With 28 degrees of freedom, a t value of 2.05 has a probability of .05, and a t value of 2.76 has a probability of .01. Hence all the differences between the examined means of the plural birth percentages (except those involving "colored" quadruplets) are statistically significant. The most important point to be observed is that the "colored" population has a

TABLE 4

Values of t obtained from comparisons of the means of plural confinement frequencies in the U. S. Birth Registration Area from 1922 to 1936 inclusive.

POPULATIONS COMPARED	*t* VALUES (t 2.05 = P .05)		
	Twin	Triplet	Quadruplet
Total — "white"	5. +	3. +	8. +
"Colored" — total	22. +	9. +	1.66
"Colored" — "white"	25. +	10. +	1.96

statistically significant higher twin and triplet confinement frequency than does the "white". The former probably also has a significantly higher quadruplet confinement frequency but with quadruplet confinements as infrequent as they are and with the "colored" population relatively small, the variance of the "colored" quadruplet confinement frequencies is too large to allow the mean to be shown to be significantly different from that of other populations.

In 1895 Hellin expressed the opinion that triplet confinements occur with a frequency equal to the square of the twin confinement frequency, and quadruplet confinements with a frequency equal to its cube. This generalization has come to be known as Hellin's law. We have no intentions of presenting here a detailed discussion of the reasons why this law might hold, but merely to present the relationships as found

in the U. S. Birth Registration Area from 1922 to 1936 inclusive, and to test how closely the observed data agree with the expected.

The observed twin, triplet and quadruplet confinement frequencies are presented in table 5. To test for the agreement between observed

TABLE 5

Observed twin, triplet, and quadruplet confinement frequencies in the U. S. Birth Registration Area from 1922 to 1936 inclusive.

POP.	TWIN		TRIPLET		QUADRUPLET	
	%	1 in	%	1 in	%	1 in
Total	1.161	86.13	.01189	8411.	.000203	492,314.
"White"	1.129	88.60	.01089	9182.	.000175	570,196.
"Colored"	1.415	70.69	.01970	5076.	.000420	237,897.

TABLE 6

Chi square values and their probabilities obtained in the testing of agreement between U. S. plural confinement frequencies and Hellin's law.

POP.	PERCENTAGES					χ^2	P LESS THAN
	Twin	Triplet		Quadruplet			
	Observed	Observed	Expected	Observed	Expected		
Total	1.161	.01189	.01348	.000203	.000156	63.	.01
"White"	1.129	.01089	.01275	.000175	.000144	87.	.01
"Colored"	1.415	.01970	.02002	.000420	.000283	22.	.01

percentage frequencies and the expected on the basis of Hellin's law the chi square (χ^2) test has been applied:

$$\chi^2 = \frac{N}{100} \Sigma \frac{(O - C)^2}{C}$$

The chi square values and their probabilities are given in table 6. The observed twin confinement frequencies of each population was taken as a base for the calculation of expected triplet and quadruplet frequencies. Therefore two degrees of freedom exist.

A χ^2 value of 9.210, with two degrees of freedom, has a probability of .01. Hence all the χ^2 values obtained have probabilities much lower than .01 which means that in none of the three populations tested do the observed plural birth frequencies agree closely with Hellin's law.

SUMMARY

1. The total (i.e. single and plural), twin, triplet and quadruplet confinement frequencies for the U.S. Birth Registration Area from 1922 to 1936 inclusive, are presented.

2. The twin percentage frequencies for the total population ("white" and "colored" combined) vary, from year to year, more than might be expected on a basis of chance. This may be due in part to genetic heterogeneity.

3. The "white" and the "colored" twin percentage frequencies also vary slightly more than might be expected due to chance.

4. The total, the "white" and the "colored" triplet percentage frequencies do not vary more from year to year than might be expected on a basis of chance. The "white" quadruplet frequencies do slightly.

5. The "colored" U.S. population has a significantly higher twin and triplet confinement frequency than does the "white". The "colored" quadruplet frequency is higher than the "white" but it is not shown to be significantly so. This is probably due to the fact that the numbers are small.

6. The plural birth frequencies of the total, the "white" and the "colored" populations are tested for agreement with Hellin's law. The agreement for none of these populations is good.

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SKELETAL REMAINS FROM PRINCE WILLIAM SOUND, ALASKA

BRUNO OETTEKING

Museum of the American Indian, Heye Foundation, New York, (retired).

SEVEN TEXT FIGURES AND FIVE PLATES

PREFATORY REMARKS

The skeletal remains collected by Drs. Kaj Birket-Smith and Frederica de Laguna during their joint 1933 Archaeological Expedition to Alaska, are more numerous than those brought back by the latter from her 1930–1931 expedition (de Laguna, '34). They consist of cranial and osteological specimens from various localities about Prince William Sound. In most cases the state of preservation is fair-to-good. The study of this material, as in the former case (Oetteking, '34) was entrusted to the present writer.

PROBLEM AND PROCEDURE

The investigation was carried on according to the following plan by which the material, grouped and subgrouped, received systematic attention:

1. Craniology: Study of the crania alone.
2. Osteology: Study of the skeletal parts outside of the crania.
3. Cranio — osteological correlations.

The absolute measurements taken upon the crania and the other bones of the skeletons were attained in the standard fashion and in compliance with the directions given by Martin ('28). Where special techniques of metrical or descriptive interpretation appeared to be necessary, these are in each case explained in the text.

The cranial capacity was taken with millet and measured in the graduated cylinder.

Angular measurements upon the crania, of which latter craniograms, i.e., orthogonal midsagittal tracings had been made, were referred to the ear — eye plane of cranial orientation.

Angular measurements upon the mandibles were based on the alveolar plane of mandibular orientation drawn into the gnathogram of lateral projection of the individual mandible according to the writer's method. It consists, on the basis of Hermann Klaatsch's and Hans Virchow's schemes (Klaatsch, '09; Martin, '28; Oetteking, '25, '30; Virchow, '16, '20), in the construction of the plane line

through the thickened edges of the alveoli for the middle incisor and the third molar of the same side, or the second molar in case the third molar is wanting. Figures 8, 10, 11 and 13.

As in most small series of skulls, sexing was somewhat fallacious. Undubitable male and female type specimens not always present and the range of morphological determinants rather wide and attenuant, personal critique had also to be relied upon in the present case.

As to the problem involved, the present contribution essays a morphological and metrical interpretation of race and type. From the total number of measurements, therefore, only such were drawn into account as seemed to be of importance for the purpose mentioned. These and the undiscussed measurements are assembled in a table (table 14: The individual measurements of the cranial material from Prince William Sound, Alaska) which has been deposited in The Wistar Institute.

The anatomical names are those of the Jena Nomina Anatomica (INA) of 1935 superseding the Basel Nomina Anatomica (BNA) of 1895. In this connection it may be mentioned that, especially in America, new efforts are under way toward a further concise clarification in anatomical nomenclature with the view to avoiding national preference (Corner, et al., '42).

I. CRANIOLOGY

MATERIAL

(Specimen, sex and age, provenience, state of preservation):

1. Cranium, ♂ ? ad.[1] — Glacier Island [2] I —

The entire right half of the skull including the mandible, is covered by the scalp parchment to which in the lower temporal region sparse tufts of hair adhere. Included in the scalp remnant is the flattened ear conch and the parched and shrivelled right eye. The color of the mummified parts is brownish-blackish with indications that ochre might have been used for decoration or staining. The color of the exposed parts of the skull and mandible varies from light yellowish-whitish to spotted light-brownish.

[1] The state of preservation of a skull, its sex and age are symbolized in the following manner: Cr, cranium, i.e., the skull and its lower jaw, which latter, if a single lower jaw, is indicated by md, mandibula; cm, calvarium, i.e., the skull without its lower jaw; ca, calvaria, i.e., the skull without its face and lower jaw; cv, calva, i.e., the skull cap. ♂ and ♀ are the familiar symbols for male and female. The age stages are signified as follow: Inf I or II, infantile ages; juv, juvenile or adolescent age; ad, mat, sen, also in combinations (ad-mat, mat-sen, juv-ad), indicate adult, mature, and senile (or intermediate stages).

[2] Except in this detailed list of specimens and in a few other places, the localities from which they derived in the Prince William Sound region will be referred to in the text in abbreviation, as follows: P.C. = Palutat Cave; P.V. = Palugwik Village; P.E.P. = Palugwik East Point; Gl.I = Glacier Island; H.I. = Hawkins Island; M.I. = Mummy Island; Txw. = Tauxtwik.

The general state of preservation is good, except for the left lacrimal which is destroyed.

Teeth:[3]

8	7	6	5	4	3	2	x	x	x	x	4	5	6	7	8
—	7	6	5	4	3	2	x	x	x	3	4	5	6	7	—

2. Cranium, ♀ juv-ad. — Glacier Island II —

This skull is distinguished by an enlargement due quite probably to a pathologically expanded brain suggestive of early hydrocephaly. The expansion toward the sides seems furthermore enhanced by slight occipital cradle board flattening. The bones are regularly jointed, while synchondrosis (fissura) spheno-occipitalis is still open. The age is an advanced juvenile stage, an estimate substantiated by the third molars which in both jaws are in eruption. The following descriptive remarks on the teeth hold good for both jaws. The incisors are distinctly trilobate and pronouncedly shovel-shaped. Indications of trilobity are also noted in the canines. The premolars are peculiarly degenerate in size and relief conditions.

On account of its immature age and particularly its anomalous size, this skull has been accounted for separately, i.e., not in group treatment with the prevailing series.

The specimen is well preserved except the lower jaw whose right angle and preangular parts of the mandibular body are damaged by weathering.

The color is dark brownish on the right side and posteriorly while the other parts, which were exposed to the air, are of a lighter hue.

Teeth:

8	7	6	5	4	x	2	1	x	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	x	2	3	4	5	6	7	8

3. Calvarium, ♀ ? ad. — Hawkins Island 413 ("Michael").

State of preservation: Fair, slightly weathered in parts, right zygomatic arch broken

Size: medium

Weight: medium

Color: whitish

Teeth:

x	x	6	x	x	x	x	x	x	x	x	x	x	6	7	x

4. Mandible, ♀ mat. — Mummy Island x.

State of preservation: Somewhat distorted, scaled and damaged

Size: medium

[3] Teeth are accounted for as follows: In each half jaw, oriented in the customary anatomical fashion, and beginning with the middle incisors, the teeth are numbered from 1–8 for the normal dentition in the adult; Roman numerals signify deciduous teeth; dashes mark non-eruption of teeth as well as obliteration of alveoli, crosses post-mortem (but also intra vitam) loss of teeth, numbers in parentheses pathological teeth, and numbers in circles teeth in eruption.

Weight: medium
Color: light dirty-brownish
Teeth:

8	7	6	x	x	x	x	x	x	x	x	x	x	6	7	8

5. Mandible, ♂ mat. — Palutat Cave A.

State of preservation: good, slightly weathered
Size: large
Weight: heavy
Color: light-to-dirty yellowish
Teeth:

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

6. Cranium, ♀ ? mat. — Palutat Cave B 1.

State of preservation: Very good
Size: rather small
Weight: rather light
Color: evenly light-brownish with dark tinges in parts
Teeth:

8	7	6	5	4	3	2	1	x	2	3	4	x	6	7	8
8	x	6	5	4	3	2	x	1	2	x	4	5	6	7	8

7. Cranium, ♂ mat. — Palutat Cave B 2 (plates 1–5).

State of preservation: Slightly damaged on left side
Size: supermedium
Weight: medium
Color: light unevenly-brownish, mandible somewhat lighter
Teeth:

—	7	6	5	4	x	x	x	1	2	3	x	5	6	7	—
8	7	6	5	4	3	2	1	1	x	3	4	5	6	7	8

8. Mandible, ♂ mat. — Palutat Cave B 2 x.

State of preservation: Right ramus gone, remainder of right side somewhat weathered, left half in a good condition
Size: supermedium
Weight: semi-heavy
Color: uneven light-brownish
Teeth:

x	x	x	x	x	x	x	x	x	x	x	x	x	6	x	8

9. Mandible, ♀ ad. — Palutat Cave B 3.

State of preservation: Well preserved
Size: small, slender

Weight: heavy, massive
Color: light dirty-brownish
Teeth:

—	x	6	5	x	3	x	1	1	x	3	x	5	6	7	—

10. Cranium, ♂ mat. — Palutat Cave C 1 (plates 1–5).

State of preservation: Well preserved, a typical male skull
Size: large
Weight: heavy
Color: dirty-brownish from a lighter hue to quite dark
Teeth:

8	7	6	5	4	3	x	x	x	x	3	4	5	6	7	8
8	7	6	5	4	3	—	1	1	2	3	4	5	6	7	8

11. Cranium, ♂ ? ad. — Palutat Cave C 2 (plates 1–5).

State of preservation: Good
Size: supermedium
Weight: heavy
Color: light dirty-yellowish-brownish
Teeth:

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

12. Cranium, ♀ ad. — Palutat Cave D.

State of preservation: Very good
Size: submedium
Weight: massive
Color: light-to-dark dirty-brownish
Teeth:

8	7	6	5	4	3	x	1	1	x	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

13. Mandible, ♀ ? mat. — Palutat Cave E–x.

State of preservation: Good
Size: somewhat small, slender, low
Weight: semi-heavy
Color: yellowish
Teeth:

8	7	6	x	4	3	2	—	x	2	3	4	5	6	x	8

14. Cranium, ♂ mat. — Palugwik Village I.

State of preservation: Good
Size: large

Weight: medium-heavy
Color: uneven brownish
Teeth:

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	x	—	2	3	4	5	6	7	8

15. Mandible, ♀ mat. — Palugwik Village II.

State of preservation: Posterior half of right ramus broken away
Size: supermedium
Weight: lightish
Color: uneven brownish
Teeth:

8	7	6	5	4	3	x	—	—	—	x	4	x	6	7	8

16. Cranium, ♀ mat-sen. — Palugwik Village III (3 c II).

State of preservation: Cranial base and face damaged, right ramus of mandible and part of corpus wanting
Size: supermedium
Weight: medium-heavy
Color: dirty pale-brownish
Teeth:

					3	—	—	—	x	x	4	5	6	—	8

17. Cranium, ♂ ? ad. — Palugwik East Point I.

State of preservation: In a good general condition, lacrimals destroyed, right zygomatic arch damaged
Size: super-medium
Weight: heavy
Color: dirty-brownish
Teeth:

x	7	6	x	x	3	x	x	x	x	3	x	x	x	7	x
8	7	6	x	4	3	x	x	x	x	3	4	5	6	x	x

18. Cranium, ♂ mat. — Palugwik East Point III.

State of preservation: Well preserved in general; zygomatic arches, left zygomatic bone and right mandibular ramus damaged
Size: supermedium
Weight: medium-heavy
Color: light dirty-brownish
Teeth:

8	7	(6)	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	x	x	2	3	4	5	6	7	8

NORMA VERTICALIS

a. Cranioscopic observations

Contour. From the cranioscopic viewpoint, using G. Sergi's schemes, the cranial outlines in this norma are fairly uniformly pentagonoid and marked by the distinctness of the parietal bosses. This is particularly true of the anomalous skull from Gl. I. II ♀ (see p. 59). The skull from P. C. B2 ♂ mat. is ellipsoid-to-ovoid in outline and that from P. E.P. I ♂ ? broadly ellipsoid-to-spheroid.

Postorbital constriction is of typical occurrence in the Indian and Eskimo skulls and is there generally associated with and signified by a small minimum frontal breadth (p. 64) and, in consequence, the visibility of the zygomatic arches in norma verticalis. Although the latter is rather a racial, i.e., in our case a Mongolid distinction, its combination with postorbital constriction is an expression of morphological primitiveness.

Arcus zygomaticus. The general statement in the preceding paragraph regarding arcus zygomaticus is based on the following individual conditions: Ten in our series of twelve skulls are outspokenly phaenozygous, one is orthozygous and one crytozygous. The latter condition obtains in the anomalously expanded skull from G. I. II ♀ (see p. 59) and must be evaluated accordingly.

Foramina parietalia are only small and in a number of cases missing, right or left in equal frequencies. When a foramen is extant in either bone, they are in most cases of unequal size.

Sutures. Obliteration of the principal sutures and following the typical chronological order of suture obliteration: sagittalis, coronalis, lambdoides, occurs in varying degrees of development in almost all of the skulls. In a few however the sutures are still open. In general, the sutures show only weak to medium liveliness of serration. The lambdoid suture, as is usually the case, displays wider and more varied excursions and occasional suture bones.

b. Metrical observations

The cranial dimensions observable in norma verticalis are listed in table 1.[4]

[4] The individual cranial measurements of some of which the ranges and averages appear in this and the following tables may be found conclusively assembled in a table (table 14: The individual measurements of the cranial material from Prince William Sound, Alaska) which has been deposited in The Wistar Institute. The unequal sex frequencies (cases) in the various measurements and tables are naturally due to the state of preservation of the specimens which in individual cases does not lend itself to the taking of measurements. For plausible physical reasons the female averages and ranges fall below those of the males although overlappings are frequent in the ranges.

The cranial length with male and female averages of 185.3 mm. (176–192 mm.) and 175.0 mm. (170–186 mm.) is seen to differ by 10 mm. in favor of the males. The cranial breadth on the other hand shows, for plausible reasons, a considerably lesser difference of 3.6 mm. between the male average of 142.6 mm. (137–148 mm.) and the female one of 139 mm. (134–149 mm.). By a similarly low figure of 3.2 mm. the sex averages differ in the minimum frontal breadth where the males yielded an average of 98.2 mm. (90–106 mm.) and the females one of 95.0 mm. (88–103 mm.). The horizontal circumference differs by about 30 mm. in

TABLE 1

Measurements in norma verticalis.[1]

MEASUREMENTS	MALE			FEMALE		
	Cases	Range	Average	Cases	Range	Average
Cranial						
Length	7	176–192	185.3	4	170–186	175.0
Breadth	7	137–148	142.6	4	134–149	139.0
Min. frontal br.	6	90–106	98.2	4	88–103	95.0
Circumference (horizontal)	6	510–540	526.3	4	482–525	496.5
Facial						
Bizygomatic breadth	6	132–156	141.3	4	126–138	132.8
Index						
Cranial L — Br	7	73.2–82.4	77.0	4	79.9–80.8	79.4
Transverse						
Parietofrontal	6	63.4–73.4	69.0	4	65.7–95.0	68.4
Craniofacial	6	96.4–105.4	99.4	3	92.6–100.8	95.6

[1] As a matter of course, metrical symbols (cm., mm., cc., °, %) have been omitted in this and other tables of measurements.

The individual cranial measurements of all the specimens of the present series may be found assembled in a table deposited in The Wistar Institute. (See also footnote 4.)

the sexes, with male and female averages of 526.3 mm. (510–540 mm.) and of 496.5 mm. (482–525 mm.).

Amongst the facial measurements it is the facial (bizygomatic) breadth which in norma frontalis dominates the anterior part of the cranial complex and which together with the relatively small minimum frontal breadth of our specimens brings forth the phaenozygous condition of the zygomatic arches. The extension of the arches differs in the sexes by 8.5 mm. on an average, the males attaining 141.3 mm. (132–156 mm.), the females one of 132.8 mm. (126–138 mm.). In spite of the smallness of the two series this proportional status reflects the sex differences obtaining in most metrical respects.

The latter find a more adequate expression in the indices. The influence of relatively smaller female cranial length and breadth manifests itself in the cranial length-breadth index with a female almost brachycranial average of 79.4 (77.9–80.8) as compared to the mesocranial male average of 77.0 (73.2–82.4); in the transverse parietofrontal index with the lesser degree of metopy, namely 68.4 (65.7–95.0) in the females (metriometopic) in contrast to the male average of 69.0 (63.4–73.4) (just eurymetopic), and in the transverse craniofacial index where the female average amounts to 95.6 (92.6–100.8) in contrast to that of the male at 99.4 (96.4–105.4), a contrast in which the relatively smaller cranial breadth and the relatively larger bizygomatic breadth of the males naturally play important parts.

NORMA BASILARIS

a. Cranioscopic observations

The basal aspect depends upon the length-breadth extension of the cranium in general and in the individual sizes of neuro- and splanchnocranium in particular. It is furthermore and quite decisively influenced by anatomical and configurative detail formations such as the extension of arcus zygomatici and the comparative width of the temporal fossae, the shape and size of the maxillopalatal complex, the development of the subsquamous and the lateral parts of os temporale, shape and size of foramen magnum, the occipital condyles, etc. An anomaly is to be seen in C2 where fissura sphenooccipitalis is not fully ossified in spite of the adult age of the specimen (see plate 4). Taking the foramen magnum as a starting point around which the anatomical and morphological detail is grouped, their discussion may begin with the description of the former.

The foramen occipitale magnum is predominantly roundish in shape with occasional approximations toward the broad ellipse, a somewhat longer ellipse being attained in H. I. (413) ♀ ? and another anteriorly and posteriorly pointed one in P. E. P. III ♂. Anomalies are absent except in the posterior circumference of foramen magnum in P. C. C1 ♂, which represents the contact zone with arcus posterior of the atlas. The crude and massy posterior margin of foramen magnum of this skull is in its full extension irregularly and shelf-like depressed without however losing much of its massiveness. A shallow but distinct emargination of the posterior rim in its midregion and primarily connected there with conditions of ossification occurs in P. C. B1 ♀ ?.

The occipital condyles are with a few exceptions low to medium high, but varying in breadth from narrow to broad in curvity and in the degree of convexity of the articular surface. High and strongly convex condyles were observed in P. C. C1 ♂. The intercondylar section of the margin is, in P. C. B1 ♀?, P. C. C1 ♂ and P. C. D ♀ ?, somewhat marred by mesial elongations of the condyles, without however the formation of precondylar tubercles.

Further laterally sulcus arteriae occipitalis and incisura mastoidea, variable per se, do not vary beyond a reasonable degree. Fossa condylica and canalis condylicus also do not represent any outstanding marks beyond the usual degree of variability. This is also true of canalis nervi hypoglossi which in a small number of cases is bipartite.

Foramina jugularia are on the average of medium size, differences of size occurring in varying proportions. Large-sized foramina with a prevalence of the left one over the right were noted in P. V. I ♂.

Tuberculum pharyngicum upon the underside of pars basilaris of the occipital bone is only mildly expressed and associated in a few cases with weak indications of a fossa pharyngica.

A feature of interest because of its dependence upon mechanico-physiological conditions is the size of fossa mandibularis which is deep and spacious in most of our specimens. In only a few instances the fossa is medium deep with flattened out tubercula articularia (P. C. C1 ♂, P. V. I ♂). The fissura petrotympanica (Glaseri) does not represent any anomalies. Tympanic perforation is completely absent, except in the case of H. I. ♀ ?, where the right tympanic plate in its midregion shows a roundish hole of almost 2 mm. in diameter.

Further in advance and by way of foramina spinae and ovalia in the size of shape of which no irregularities were noted, the processūs pterygoides are invariably distinguished by larger-sized laminae laterales and, in correlation therewith, spacious and deep pterygoid fossae. In some cases the breadth of the lateral plate is remarkable as, f.i., in P. C. C1 ♂, where also indications of foramina Civinini are noticed. A true foramen Civinini (pterygospinosum) is seen on the left side in P. C. B1 ♀ ? which is here supplemented by a special bridging of foramen spinosum and which latter occurs also on the right side of the same skull without the formation of a pterygospinous foramen.

In the maxillopalatal complex it is particularly the form of the dental arch which is of interest. Paraboloid in general, it shows in a number of cases a wide anterior rounding as, f.i., in P. C. B1 ♀ ? and H. I. (413) ♀ ?, notwithstanding the otherwise typical sex distinction of a narrower anterior curve in the female mandible. An approximation of the upsiloid

form of the dental arch is seen in P. C. B1 ♀ ? and especially in P. V. I ♂ where even the anterior curve is flattened down and more or less adjusted to a straight line extended between the canines. A difference in the length of the two halves of the dental arch and consequently the alveolar processes where those of the right exceed those of the left side, also metrically confirmed and previously referred to by the writer (Oetteking, '31, pp. 450–451), appears to be the rule in the present series. This condition is also reflected in the size of the halves of the palate with the right half more spacious than the left. With a few exceptions (H. I. 413 ♀ ?) the depth of the palate is quite pronounced. The relief formations and those resulting from configurative conditions do not vary beyond a reasonable measure. Torus palatinus however in varying degrees of development up to medium expression is present in all the specimens except one (P. E. P. III ♂). Somewhat more variable, as is the rule, is the shape of spina nasalis posterior which is either pointed, truncated or rounded.

The teeth of the maxilla had erupted in all instances (see list of specimens, p. 58) except in P. C. B2 ♂ which is without its upper third molars. The teeth on the average are of medium size, although in a few instances (Gl. I. II ♀ ?, P. C. C2 ♂ ?) the middle incisors seem to exceed the average size. Shovel-shape of the incisors as far as could be ascertained is the prevailing condition. The phylogenetic tendency of diminution in size is also the trend in the maxillary second and third molars of the present series. The wear of the occlusal surfaces occurred in most cases on a level with the horizontal plane. There is only one example (P. V. 1 ♂) of an abrasion in the typical Indian way, i.e., in the upper teeth superolingually-inferobuccally with the contrasting conditions in the lower jaw. The attrition here has gone so far, as also frequently encountered in Indian skulls, as to lay bare the pulp cavities of the first molars in each jaw half. As regards pathological conditions, caries is entirely absent. But there is a case of alveolar resorption, attritional trauma due to suppuration on the lingual side of P. C. B2 ♂ , a condition not so very rare in the coast tribes of the North Pacific.

b. Metrical observations

The outstanding measurements in norma basilaris are those of the foramen occipitale magnum and of the maxillopalatal complex, they are assembled in table 2.

The length of foramen occipitale magnum differs but slightly in the sexes, the male average amounting to 35.0 mm. (31–38 mm.) and the female to 32.7 mm. (31–34 mm.). The width averages are nearly alike

at 29.0 mm. (27–32 mm.) in the males and 28.0 mm. (27–30 mm.) in the females. These conditions are reflected in the index where the average of the male index at 83.1 (71.1–91.4) falls below that of the females at 85.8 (79.4–90.9).

In the maxillopalatal complex it is the maxilloalveolar measurements which on account of the phylogenetic changes taking place in this plastic region are of special interest. The conditions for the purpose of metrical comparison are somewhat aggravated because of the paucity of female specimens and the metrical diversity in one of the female specimens

TABLE 2

Measurements in norma basilaris.

MEASUREMENTS	MALE			FEMALE		
	Cases	Ranges	Average	Cases	Ranges	Average
Cranial						
Foramen magnum						
Length	7	31–38	35.0	3	31–34	32.7
Width	7	27–32	29.0	3	27–30	28.0
Facial						
Maxilloalveolar						
Length	7	47–60	54.9	3	53–57	54.7
Breadth	7	63–72	67.6	3	60–70	66.0
Palatal						
Length	7	42–51	47.3	3	45–46	45.3
Width	7	40–46	42.4	3	38–41	39.3
Indices						
Foramen magnum	7	71.1–91.4	83.1	3	79.4–90.9	85.8
Maxilloalveolar [1]	7	117.9–134.0	123.5	3 (2	105.3–132.1 125.9; 132.1	121.1 129.0)
Palatal	7	78.4–100.0	90.0	3	82.6–91.1	86.8

[1] In the maxilloalveolar index the female figures are listed either with or without the inclusion of the extremely low index of 105.3.

(P. C. D ♀, see below under maxilloalveolar index). In the maxilloalveolar length the averages with 54.9 mm. (47–60 mm.) in the males and 54.7 mm. (53–57 mm.) in the females coincide in the sexes. Slightly differing in proportion are the figures found for the maxilloalveolar breadth with male and female averages of 67.6 mm. (63–72 mm.) and 66.0 mm. (60–70 mm.). The maxilloalveolar index computed from these two measurements turns out somewhat incongruently in the female. There is quite a hiatus between the lowest female value of 105.3 (P. C. D ♀) and the next two of larger size in the same sex and which yielded indices of 125.9 and 132.1. The female averages with or without the

inclusion of the low index amount to either 121.1 or 129.0, i.e., both female averages are brachyuranic, notwithstanding the inclusion of the dolichuranic individual index of 105.3 in the lower average. The conditions in the males are more unified in the brachyuranic average of 123.5 from a range of 117.9–134.0, which is entirely brachyuranic.

The palatal measurements are naturally somewhat more concentrated. The palatal length averages are 47.3 mm. (42–51 mm.) and 45.3 mm. (45–46 mm.) in the sexes, while the palatal width has a male average of 42.4 mm. (40–46 mm.) and a female one of 39.3 mm. (38–41 mm.). The palatal index reiterates the general morphological conditions of the maxillopalatal complex, i.e., both averages of the index are brachystaphyline with 90.0 (78.4–100.0) and 86.8 (82.6–91.1) in the sexes while the ranges comprise lepto- and mesostaphyline values in the males and one mesostaphyline value in the females.

NORMA LATERALIS

a. Craniscopic observations

Contour. The cranial contour in norma lateralis, identified in the midsagittal tracing, accounts in all the specimens in general for a well-rounded brain-case while that of the face represents some characteristic detail formations.

The frontal arc, although well developed, shows in a few instances the slight flattening frequently found in the American Indian (P. C. D ♀), but there is no indication of artificial deformation in any of the skulls of this series.

The glabella region shows the usual sex difference of protrusion and is particularly well defined in P. C. B2 ♂, a skull which in other respects also is distinctive from the rest (see under occipital arc).

The parietal arc invariably rises above the level of the bregma in ear–eye orientation, i.e., above a parallel to the ear–eye plane laid through the bregma. The metrical account of the postbregmatic elevation is given on p. 76.

The occipital arc also is well rounded and thus completes the midsagittal arc posteriorly and posteroinferiorly. In most cases the inion flexure is only faintly indicated. But there is one skull in our series (P. C. B2 ♂) which in its occipital morphology stands out from the rest of the lot and which denotes a primitive condition prompted also by some of the metrical findings discussed farther below. The outstanding feature in the occipital outline, let alone its physiological motivation, is the decided protrusion of the superior squama and, in consequence,

the marked flexure against the inferior squama. Such a condition is primitive in the sense of morphological advance in the region under discussion, linkable to conditions in Homo primigenius and repeated in certain primitive varieties of Homo sapiens. The craniological study of the American Indian in general has brought to light a number of instances where the occipital conditions as described, and in association with other primitive marks, prevail. In this connection the Punin skull (American Museum of Natural History, $\frac{99}{8271}$; Sullivan and Hellman, '25) whose mediansagittal tracing (mihi) has been used in the superposed cranial outlines in figure 3, is of prototypical importance. Superpositions for the purpose of delineating the morphological relationship

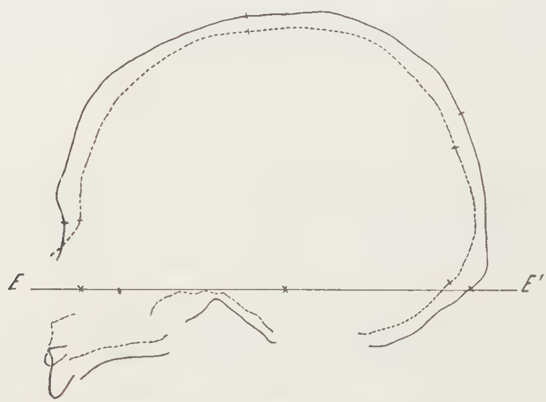


Fig. 1 Superposition of mediansagittal cranial tracings to show in a male and female skull the predominating roundishness of outline. ————, Palugwik East Point III♂; – – –, Hawkins Island 413♀. — Orientation: Male on ear–eye plane (*E–E'*), superposition on bregma height-line. ½ natural size.

of two cranial outlines in comparison, have been resorted to in this chapter in a number of cases illustrated in the following figures. Figure 1 shows the predominating male (P. E. P. III ♂) and female (H. I. 413 ♀) tracings which bear out the above statements with regard to the rather evenly rounded midsagittal outlines. The female outline fitting well into that of the male remains distinctly the weaker especially in the glabella and inion developments. In figure 2 two male midsagittal tracings are superposed, of which the interrupted one is the male of figure 1 (P. E. P. III ♂), and the solid one that of P. C. B2 ♂ referred to in several places of this section as an outstanding type. Comparatively, it is recognized immediately as markedly lower and provided with a strongly protruding occiput which develops from a strikingly

tapering parietal outline. The morphology of this skull is indicative of an inferior craniological type expression and has its almost exact replica in the famous Punin skull referred to above and upon which it is superposed in figure 3. A striking coincidence of the tracings of the neurocrania will immediately be perceived. Easily realized in both skulls are the glabellar developments, the relative lowness of the cranial vaults foreshadowed by the somewhat declining forhead lines which

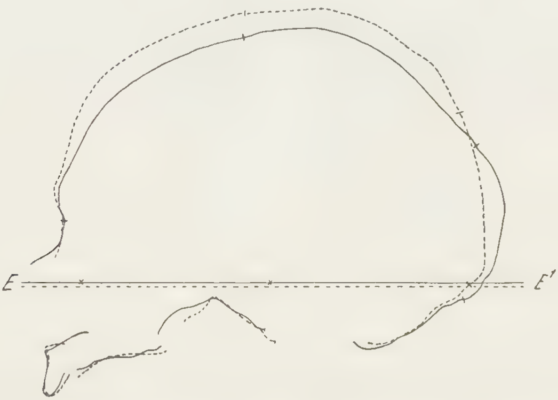


Fig. 2 Superposition of mediansagittal cranial tracings to show in two male skulls the prevailing type differences (see text). ————, Palutat Cave B2♂; – – –, Palugwik East Point III♂. — Orientation: Ear–eye plane *(E–E')*, the nasia coinciding. ⅓ natural size.

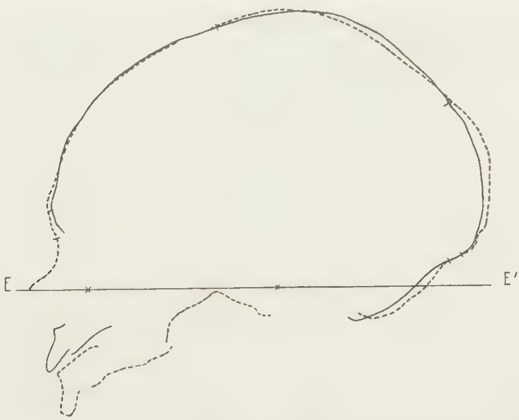


Fig. 3 Superposition of mediansagittal cranial tracings to show in two skulls type similarities of a morphologically inferior kind. ————, Palutat Cave B2♂; – – –, Punin ♀? (Am. Mus. Nat. Hist., $\frac{99}{8271}$). — Orientation: Punin on ear–eye plane (*E–E'*), superposition on glabella–lambda line. ⅓ nautral size.

continue into distinct postbregmatic elevations. After these the cranial outlines slant rather rapidly into the occipital protrusions and the marked flexures below the inia. Both the protrusion and the flexure in the tracing of figure 3 are in fact the most outstanding and in their morphological significance primitive characteristics, by which they are distinguished from the general rounding of the occipital region in the rest of our series and which as such indicates morphologic advance. The occipital flexure referred to was also noticed by the writer in the skull of an eastern Eskimo from Southampton Island in the collections of the American Museum of Natural History ($\frac{99}{4102}$)[5] and brought in superposition with our own Eskimo skull in figure 4. The occipital

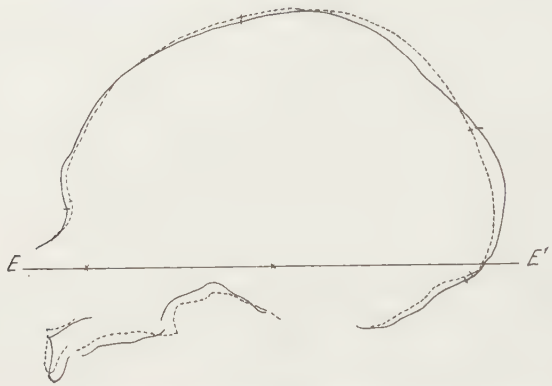


Fig. 4 Superposition of mediansagittal cranial tracings to show in two Eskimo male skulls type similarities of a morphologically inferior kind. ————, Palutat Cave B2♂; – – –, Eastern Eskimo ♂, Southampton Island (Am. Mus. Nat. Hist., $\frac{99}{4102}$). —Orientation: Palutat Cave B2♂ on ear–eye plane *(E–E')*, superposition on glabella–lambda line. ⅓ natural size.

flexure shown there in the interrupted line, is even more pronouncedly developed than in our skull, although the former's occipital protrusion remains below the outline of that of the latter while its suprainial bulge (bregma–inion section) displays a much more evenly rounded curve.

Of the facial parts visible in the tracings of our series, it is particularly the nasal bridge and spina nasalis anterior which deserve mention. The former shows in most cases the characteristics of the Mongolian nose. These must be seen (1) in the close adherence, in the upper part of the nasal bridge, of the nasal tracing to the perpendicular dropped in the nasion point from a parallel to the ear–eye plane (*e–e'*) laid

[5] The feature under discussion may and really does occur in series of American crania not as rarely as might be presumed.

through the nasion, and (2) in the more or less total concavity of the nasal curve. Good examples for this are seen in figure 5, *A* and *B*, while *C* is somewhat less concave and *D* rather straight with a beginning incurvation in the terminal part. The latter, in combination with the former two characteristics, appear to be emphasized in *E*, whose outline is also used in the demonstration of the features described in *F*, with the assistance of a number of auxiliary lines as explained in the legend. Spina nasalis anterior in all the specimens shows a medium development, not lophacanthic in Macalister's terminology, but rather representing a medium degree of oxyacanthy with occasionally a more pronounced development as in the skulls from H. I. 413♀ and from P. C. D♀.

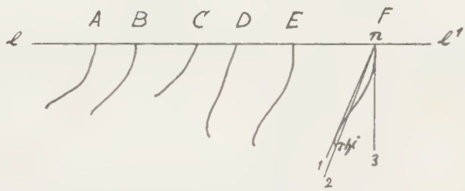


Fig. 5 Nasal bridge. — Showing different stages of curvation (concavities and convexities) in: *A*, Palutat Cave B2♂; *B*, Palugwik East Point I♂?; *C*, Hawkins Island 413♀; *D*, Glacier Island II♀; *E*, Palutat Cave C1♂; *F*, same as *E*. — *e–e'*, parallel to ear–eye plane through *n*, nasion; *rhi*, rhinion. — *n–1*, tangent to show upper concavity of nasal outline; *n–2*, nasion–rhinion line to show upper concavity and lower convexity of nasal outline; *n–3*, nasion perpendicular. ½ natural size.

A number of varying conditions about porus acusticus externus bear certain morphological significance. The porus itself is, in all the specimens, round or roundish, in a number of cases oblong and on the average supermedium in size. Thickening of the tympanic bone (osteoma) around the free edge of the porus is present in varying degrees in all the specimens. See also "tympanic perforation" (p. 66).

Crista supramastoidea and in proportional relation therewith sulcus supramastoideus (Waldeyer) are well developed as is the rule in Indian and Eskimo skulls, with a disposition toward greater distinctness in the males. A case of remarkably strong crista development is that of P. V. I♂.

Sex differences occur likewise in the morphological status of processus mastoides which appears to be larger and bulkier in the male skull in contrast to smaller size, slenderness and pointedness in the female. The outer surface is sometimes considerably roughened by muscular insertions as, f.i., in the case of P. E. P. III♂.

In the fossa temporalis region, the fossa itself being proportionate to the pronounced bizygomatic extention (see p. 63), is rather spacious. On the other hand, the longitudinal depression upon the temporal surface of ala magna, the sulcus sphenoparietalis, is in most cases shallow–medium deep. Pterion variations (fig. 6) are observed in the length of sutura sphenoparietalis which in figure 6, (1) attains 2 mm. (stenocrotaphy) and 7 mm. respectively upon the left and right sides of Gl. I. II ♀, (2) 11 mm. and 16 mm. of H. I. 413 ♀ ?, while (3) P. E. P. I ♂ ? shows a true epiptericum on the left side and sutural bones on the right.

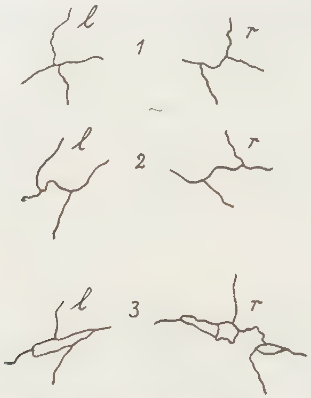


Fig. 6 Pterion variations upon left (*l*) and right (*r*) sides of skulls. — 1. Glacier Island II♀ juv–ad; 2. Hawkins Island 413♀? ad; 3. Palugwik East Point 1♂? ad. See text. ½ natural size.

Processus marginalis of processus frontosphenoideus of the zygomatic bone for the insertion of fascia temporalis is pronounced in its development in only a few cases, sharply pointed in H. I. 413 ♀ ? and widely curved in P. C. C1 ♂.

The zygomatic arches vary between superiorly straight and slightly concave. An indication of a "Henkel"-form is shown by P. V. 3cII ♀.

b. Metrical observations

More so than in any one of the other normae does norma lateralis lend itself to wide craniometric interpretation. The measurements accounted for in this norma will be found assembled in table 3.

The cranial length as already referred to in the preceding norma where it represented the maximum anteroposterior diameter in the vertical aspect of the skull (p. 64), is in norma lateralis contained in the midsagittal section and thus represents the greatest anteroposterior diameter of the cranial expanse in the lateral aspect.

TABLE 3

Measurements in norma lateralis.

MEASUREMENTS	MALE			FEMALE		
	Cases	Range	Average	Cases	Range	Average
Cranial						
Length	7	176–192	185.3	4	170–176	175.0
Height						
Total (*ba-b*)	7	127–143	135.9	3	123–131	127.7
Auricular	6	108–121	117.8	3	107–107	107.0
Infraporial	6	14–25	20.7	3	17–24	21.2
Length						
For. magnum	7	31–38	35.0	3	31–34	32.3
Cranial base	7	96–107	101.3	3	95–104	98.0
Mediansagittal						
Arc (*n-o*)	6	366–384	375.3	3(4)	334–350(382)[1]	344.3 (353.4)
Circumference	6	499–526	512.3	3	468–480 [2]	474.7
Os frontale						
Arc mid-sag.	6	124–137	128.2	4	107–122	117.0
Chord mid-sag.	7	110–118	112.5	4	101–110	106.0
Elevation	6	22–28	24.5	3	18–23	21.0
Os parietale						
Arc mid-sag.	6	109–124	116.3	4	105–116(129)	116.3
Chord mid-sag.	6	99–120	108.0	4	93–116	103.8
Elevation						
Total	6	19–25	20.7	3	19–23	21.7
Postbregm.	6	1–6	3.2	3	0.5–5	3.2
Height location (postbr.)	6	19–33	26.3	3	23–30	27.3
Os occipitale						
Arc total	6	117–143	130.8	4	109–131	119.8
Chord total	6	99–111	122.0	4	91–104	97.3
Arc sup. squ.	6	72–102	81.7	4	60–82	71.8
Chord sup. squ.	6	64–90	73.0	4	55–74	65.0
Elevation						
Total	6	23–38	32.2	3	27–34	29.7
Sup. squama	6	8–17	12.8	3	8–14	10.7
Facial						
Total height	7	118–136	126.4	2	114; 115	114.5
Upper facial height	7	74–84	78.4	3	66–74	70.7
Length	7	95–109	102.9	3	101–103	101.7
Indices						
Cranial [3]						
Length-height	7	66.2–80.7	73.4	3	71.5–76.2	74.5
Height (*Hrdlička*)	7	73.7–90.1	82.2	3	79.1–84.9	83.2
Auricular height	6	56.3–68.2	63.3	3	62.2–62.9	62.4
Sag. frontal	6	86.1–89.8	88.6	4	89.4–91.8	90.5
Sag. parietal	6	90.8–96.8	92.8	4	88.6–89.9	89.2
Sag. occipital	6	76.9–87.2	80.7	4	79.2–83.5	81.5
Sag. sup. squ. occip.	6	85.3–91.3	89.6	4	90.1–91.3	90.7
Angles						
Central (*Klaatsch*)	6	92–96	93.8	3	90–96	92.7
Craniofacial (*Falkenburger*)	6	85–90	88.0	3	89–91	90.3
Frontal	6	46–51	49.0	3	47–50	48.3
Parietal	6	16–36	25.3	3	22–31	26.0
Occipital						
Total	6	111–123	117.3	3	114–119	116.0
Upper squama	6	84–103	91.3	3	86–94	91.0
Interoccipital	6	109–136	119.0	3	119–122	120.7
Foramen magnum	6	— 2 to — 10	— 4.0	3	— 3 to — 12	— 6.0
Prognathy						
Facial	6	82–88	83.8	3	75–79	77.0
Midfacial	6	82–89	84.8	3	77–83	79.3
Alveolar	6	78–85	80.5	3	69–77	72.7
Index gnathicus	7	96.0–104.1	99.7	3	102.0–106.3	103.8

[1] This extreme female value was parenthesized in the "range" column. In the "average" column the two figures represent the averages without and with the inclusion (parenthesized) of that extreme value.

[2] The mediansagittal circumference for the extreme value listed in the preceding measurement could not be computed because of the wanting foramen magnum length.

[3] See index gnathicus under prognathy (this table).

The cranial height diameter between the basion and bregma points yields averages of 135.9 mm. (127–143 mm.) in the males and 127.7 mm (123–131 mm.) in the females. It thus differs in the sexes by about 8 mm. in favor of the males whose minimum individual value however falls as low as 127 mm. and which value belongs to the extraneous skull type from P. C. B2 ♂, referred to on page 69.

A factor involved in the cranial height concept is the postbregmatic elevation which has been accounted for here with the parallel to the ear–eye plane laid through the bregma for a basis, and on this same line the location of the greatest postbregmatic elevation. The range of postbregmatic elevation runs from 0.5–6 mm. (♂ 1–6 mm., ♀ 0.5–5 mm.), with male and female averages of 3.2 mm., while the range of location of the highest point posteriorly of the bregma lies between 19–33 mm. (♂ 19–33 mm., ♀ 23–30 mm.), with averages of 26.3 mm. and 27.3 mm. in the sexes. It will thus be seen that the maximum, i.e., the basion–vertex cranial height, differs from the basion–bregma height by approximately the amount of postbregmatic elevation in favor of the former height diameter.

Of further importance in judging the cranial elevation is the measurement of the height of the cranial vault known as the auricular height which lies projectively between the porion and bregma points. Below the porion, the infraporial extension of the cranial height affords an estimate for the development of the cranial base and is thus involved in the cranial height extension. In the auricular height the male and female averages amount to 117.8 mm. (108–121 mm.) and 107.0 mm. (107–107 mm.). The lowest male value as might have been expected falls to the extraneous type of P. C. B2 ♂. The female range with all its values centering on 107 mm., lies with this figure just below the lowest value of the male range. The auricular height, as may be gained from table 3, differs on the average likewise by 10 mm. in the sexes, and there is also a fair equality of sex differences amounting to 18.1 mm. in the males and to 20 mm. in the females between the total and auricular heights. The projective infraporial extension between porion and basion yields averages of 20.7 mm. and 21.3 mm. in the sexes with ranges extending from 14–25 mm. and from 17–24 mm. respectively.

The midsagittal cranial arc between nasion and opisthion possesses a considerable sex difference of averages amounting to 31 (22) mm. in favor of the males, the parenthesized figure accounting for the inclusion into the range of the extremely high female value of 382 mm. from P. V. III3c II ♀. The male average comes to 375.3 mm. (366–384 mm.), the female either to 353.4 mm. (334–382 mm.), or to 344.3 mm. (334–350

mm.) respectively, i.e., with or without the inclusion of the high individual value mentioned. In the enlargement of the midsagittal arc to a midsagittal circumference under the inclusion of the foramen magnum and cranial base lengths, the disparity in the average figures for the midsagittal arc as caused by the last named specimen, does not become evident for the reason that that specimen is devoid of those supplementary diameters. The length diameters of foramen occipitale magnum in the sexes run from 31–38 mm. and from 31–34 mm., the averages amounting to 35.0 mm. in the males and 32.3 mm. in the females (see p. 67). The cranial base on the other hand shows typical sex differences in favor of the males whose average amounts to 101.3 mm. (96–107 mm.) against that of the females of 98.0 mm. (95–104 mm.). The latter two measurements when added to the midsagittal arc tend to emphasize the sex differences in the figures for the midsagittal circumference. Here the averages attain 512.3 mm. (499–526 mm.) in the males and 474.7 mm. (468–480 mm.) in the females.

The three participants in the midsagittal arc, the frontal, the parietal and occipital arcs, are each of diagnostic importance:

Os frontale. The inclination of the frontal bone in the cranial complex may be judged by the angular relation of its chord (n–b) to the ear–eye plane line or better, a parallel to the latter laid through the nasion point. The male and female averages of 49.0° (46°–51°) and 48.3° (47°–50°) are almost identical, the ranges naturally keeping within narrow limits. The maximum frontal elevation above the nasion–bregma chord with 24.5 mm. (22–28 mm.) in the males exceeds that of the females with 21.0 mm. (18–23 mm.), a proportion similarly expressed by the sagittal frontal index with male and female averages of 88.6 (86.1–89.8) and 90.5 (89.4–91.8) respectively. For the frontal arcs and chords see table 3.

Os parietale. The inclination of the parietal chord on the parallel to the ear–eye plane line laid through the lambda is, on the average, fairly alike in the sexes where in the males it amounts to 25.3° (16°–36°) and in the females to 26.0° (22°–31°). The maximum elevation above the parietal chord attains 20.7 mm. (19–25 mm.) in the males and 21.7 mm. (19–23 mm.) in the females who are thus seen to rise slightly above the males. As in the frontal region, this disparity finds another expression in the sagittal index which in the parietal region yields a male average of 92.8 (90.8–96.8) in contrast to the female index average of 89.2 (88.6–89.9). For the parietal arcs and chords see table 3.

Os occipitale. This structurally and phylogentically so important part of the cranial vault which admits of a division of the squama into

an upper and lower portion, affords a more differentiated treatment than the two preceding parts. Of particular significance is here the protrusion of squama superior whose maximum height above the lambda–inion chord averages 12.8 mm. (8–17 mm.) in the males and 10.7 mm. (8–14 mm.) in the females, while in a similar sex proportion the elevation of the entire squama above the opisthion–lambda chord averages 32.3 mm. (23–38 mm.) in the males and 29.7 mm. (27–34 mm.) in the females. As in the frontal and parietal sections, the sagittal indices of the occipital bone reiterate what had been found with regard to the elevation above its respective chords. Thus the sagittal index of the upper occipital squama yielded averages of 89.6 (85.3–91.3) in the males and 90.7 (90.1–91.3) in the females. The sagittal index of the entire squama expressing the comparatively greater bulge of the occiput as such attains averages of 80.7 (76.9–87.2) in the males and 81.5 (79.2–83.5) in the females. For the occipital arcs and chords see table 3. The inclination of squama occipitalis in its entirety on the ear–eye plane, i.e., its parallel laid through the opisthion, differs slightly in the sexes with averages of 117.3° (111°–123°) and 116.0° (114°–119°). The smaller female angle seems to be correlated to the greater degree of roundheadedness typical in the female skull. The inclination of the superior squama with 91.3° (84°–103°) in the males and with 91.0° (86°–94°) in the females is identical in the sexes. Quite characteristic and reflecting the specific morphology of the occiput from the viewpoint of sex differences is the interoccipital angle between the chords of the upper and the lower squama, the vertex point of the angle being the inion craniometrical point. The female average of 120.7° (119°–122°) exceeds the male average of 119.0° (109°–136°), a sex difference perhaps also due to the rounder female head.

Face. Of the two facial diameters considered in this norma, the facial length averages of the sexes vary but slightly with 102.9 mm. (95–109 mm.) in the males and 101.7 mm. (101–103 mm.) in the females, in spite of the fact that the individual values of the male range exceed those of the female range by 6 mm. in either extension of the latter. The upper facial height with a male average of 78.4 mm. (74–84 mm.) against a female average of 70.7 mm. (66–74 mm.) connotes a characteristic difference from the viewpoint of sex, a condition to be referred to again in the metrical discussion of norma frontalis (p. 84).

Indices. The cranial length–height index, reflecting in norma lateralis the proportion between the two outstanding diameters in norma lateralis, show orthocranial average conditions in both sexes, namely, 73.4 (66.2–80.7) in the males and 74.5 (71.5–76.2) in the females. Individually

as judging from the ranges, there is to be noticed also in both sexes a slight tendency toward hypsicrany. The extraneous type specimen P. C. B2♂ turns out decidedly chamaecranial with an index of 66.2 as brought about by the comparative lowness and in contrast the marked length of the skull. The somewhat complexer but very useful cranial height index of Hrdlička ('16, p. 116) according to the formula $\frac{H \times 100}{\frac{L+Br}{2}}$ also yields with 82.2 (73.7–90.1) in the males and with 83.2 (79.1–84.9) in the females equable averages. In this latter index too the male range is quite extensive. The extraneous specimen from P. C. B2♂ is also seen to occupy one of the lowest values of 76.1. With an index of 73.7 it is exceeded in lowness by P. C. C1♂ whose larger cranial length of 190 mm. thus plays a determining part in the shaping of the index. The length–auricular height index corroborates the proportional findings and conditions revealed by the other two height indices with averages of 63.3 (56.3–68.2) in the males and 62.4 (62.2–62.9) in the females. The male average is just hypsicranial, the female orthocranial, but on the hypsicranial side.

Angles. The angular relations of the cranial parts from the viewpoint of general cranial architectonics are best expressed by the "central angle" (Klaatsch) and the "craniofacial angle" (Falkenburger). Both these angles vary around 90° which at this precise figure may be expressive of an ideal condition of the interdependence of the cranial parts. The central angle lying superoanteriorly to the intersection of the glabella–lambda and basion–bregma lines produces averages above 90° in the sexes of our series, i.e., 93.8° (92°–96°) in the males and 92.7° (90°–96°) in the females. The averages of the craniofacial angle which lies superoanteriorly to the intersection of the cranial base and prosthion–bregma lines, proximate the norm of 90° somewhat closer with a male average of 88.0° (85°–90°) and a female one of 90.3° (89°–91°). The frontal and foramen magnum angles, both referred to the ear–eye plane, are of phylogenetic importance. The former has already been discussed in connection with the respective bone (p. 77). The foramen magnum angle averages — 4.0° (— 2° to — 10°) in the males and — 6.0° (— 3° to — 12°) in the females, averages and ranges which are expressive of an advanced phylogenetic condition.

Prognathism. The state of prognathism for the facial, midfacial and alveolar angles is with averages above 80° mesognathous in the males in contrast to the prognathous female averages below 80°. Although such proportions appear to be the usual status in the sexes, the marked differences in the present series are doubtless due to the small number

of female specimens which represent pronounced prognathous average conditions even in the midfacial angles, and it is in fact only in the range of this region that one of the female specimens which attains an ortho- instead of a prognathous angle (P. C. B1 ♀). The males on the other hand show prognathous values only in the range of alveolar prognathy where P. C. B2 ♂, P. C. C2 ♂ ? and P. V. I ♂ have angles of 78° and 79°, i.e., close to the boundary between pro- and orthognathy. The determination of prognathism by means of Index gnathicus (Flower) results in corresponding findings with a mesognathous male average of 99.7 (96.0–104.1) and a female orthognathous average of 103.8 (102.0–106.3).

NORMA FRONTALIS

a. Cranioscopic observations

Contour. The cranial contour in norma frontalis comprises parts of the neuro- and splanchnocranium and is furthemore influenced and determined by a number of morphologic details such as the breadth of the face, the frontal bone contour, the infrazygomatic crest, the mandibular contour, etc. The cranium is viewed in ear–eye orientation.

The neurocranial contour in which, in norma frontalis, the frontal, parietal and temporal bones participate is more or less distinctly gable-roofed in all the specimens except in P. V. I ♂ where it appears to be more evenly vaulted from side to side. In most specimens the cranial walls are rather straight and perpendicular, in illustration of the prevailing narrowheadedness, but well-bulged in the more shortheaded crania. The visiblity in perspective, of the temporal bones is increased on account of the narrowness of the frontal bone as signified by the mesial approximation of the frontal lineae temporales. The latter show in nearly all our specimens pronounced incurvations in the lower thirds of their courses, and in consequence thereof a marked lateral deviation of the zygomatic processes of the frontal bone. The upper facial breadth-diameter (outer biorbital breadth) therefore exceeds the minimum frontal breadth-diameter quite distinctly (see under Metrical Observations, p. 84).

In the facial contour proper, the facial breadth, i.e., the bizygomatic extension already referred to in norma verticalis as a Mongolid feature (p. 64), comes into full evidence in norma frontalis and is particularly well developed in P. C. CI ♂ and P. V. I ♂. The degree of development of the zygomatic arches corresponding to that of most morphological features is weaker in the females where however the feature in question is sufficiently recognizable in proportion to the other configurative de-

tail quoted above. Crista infrazygomatica (see first paragraph) is quite variable in its morphologic behavior as will be noticed in figure 7, *a–d,* and may furthermore be modified in the individual case by the relative height of the alveolar process. It is almost straight in *a* (P. C. B2 ♂) and slightly curved in *b* (H. I. 413 ♀), while in *c* (P. V. I ♂) and *d*

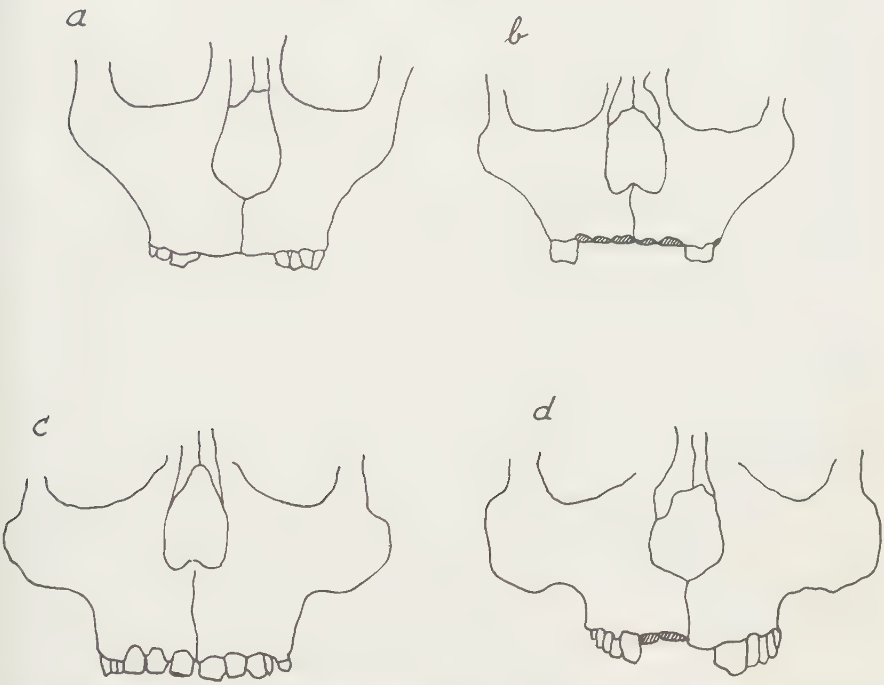


Fig. 7 Variations of crista infrazygomatica. —*a,* almost straight (Palutat Cave 2♂); *b,* shallowy curved (Hawkins Island 413♀); *c,* strongly curved with high alveolar process (Palugwik Village I♂); *d,* strongly curved with low alveolar process (Palutat Cave C1♂).

(P. C. CI ♂) the crista is strongly curved under varying height conditions of processus alveolaris. In the lowermost region of the facial contour the outline is characterized by everting mandibular angles, a feature quite obvious in the male jaws, while anteriorly the outline in the chin region is in the majority of cases well rounded, and in a few instances slightly narrowed, but never angular. The contour is furthermore influenced by the strong development of the inferomedial portion of the zygomatic body and the likewise strongly developed inferolateral portion of processus zygomaticus of the maxillary bone. The individual degree of development of these parts, as, e.g., in P. C. CI ♂, is added to

by the tendency of their orientation toward the frontal plane and the behavior of crista infrazygomatica, i.e., its varying degree of curvation, a detailed description of which has just been given. All these details bring about, in norma frontalis, a somewhat squarish appearance of the skulls in their inferior regions, while superiorly of the zygomatic protrusions there is to be noted a slight bilateral narrowing which ends in the gabled roof (crista sagittalis) referred to above.

Tubera frontalia are rather weakly developed and more closely approximated in the typically narrow foreheads of our series in contrast, f.i., to the somewhat broader forehead of P. V. 3cII ♀, where the tubera are ostensibly farther removed one from the other.

Arcus superciliares are on the average of a submedium development. Extreme cases are illustrative either of the almost total lack of the eminences as is the more or less general occurrence in the female foreheads, or they represent in a few cases supermedium development as in the outstanding type of P. C. B2 ♂, in P. C. C1 ♂ and P. V. I ♂. The latter conditions approximate the stage of medium development in Cunningham-Schwalbe's scheme of supraorbital protrusion (Martin, '28, p. 876).

The glabellar protrusion proportionally reflects that of the supraorbital eminences, i.e., it is on the average rather weakly developed.

The pars nasalis of the frontal bone with regard to its breadth extension is accounted for under ''interorbital breadths'' (see table 5, and p. 86). Referring to it also from a metrical point of view in the present context seems to be justified because of its significance from the comparative morphological angle. Thus while an extensive length appears to be an inferior mark, its comparatively great breadth is a progressive one and as such a true human condition commensurate with the development of the ethmoid labyrinths. The writer realizing the metrical fallacy of the length of pars nasalis in using the nasion point because of the variable behavior of sutura nasofrontalis encroaching upon the nasal process, has introduced a corrective measurement for the latter's length by establishing the infranasion metrical point.[6] The two length measurements (supraorbitale–nasion and supraorbitale–infranasion) differ in the present series, as may be seen from table 4, by 3.3 mm. in the males and 2.4 mm. in the females, the sex differences in each of the measurements amounting to only a fraction of a unit being rather negligible.

[6] The infranasion mihi is the point of intersection between a line connecting the two maxillo-nasofrontal points (meeting point, on each side, of suturae nasomaxillaris, frontomaxillaris and nasofrontalis) and the midsagittal plane line (Oetteking, '20, '26, '30).

Sutura nasofrontalis which in the human varieties as a rule is quite variable in its morphology (Oetteking, '20) is also in our small series of varying appearance. In the order of increasing frequency: 1 of the specimens had a sutura nasofrontalis of triangular shape; 2 were trapezoid, 3 roundish, and 5 straight.

Sutura frontalis s. metopica generally occurs in traces above the nasion. P. C. C1 ♂ shows distinct traces of this suture also toward the bregma.

The nasal bones are on the average somewhat narrowly winged, the nasal bridge already referred to (p. 72) is well defined, but the nasion region rather flat.

Orbits. The configuration of the face is decisively influenced by the orbital and nasal apertures. The former is prevailingly large, roundish

TABLE 4

Length of pars nasalis of frontal bone.

PRESENT SERIES:		SUPRAORBITALE—NASION		SUPRAORBITALE—INFRANASION	
Sex	Cases	Average	Range	Average	Range
Males	7	9.6	8–11	12.9	11–15
Females	3	10.3	9–12	12.7	11–15

or broadly elliptic with well-rounded inferolateral angles which latter feature is quite typical in the American Indian and causative in a less lateral downward slant of the width diameter of the orbit. The breadth of the "interorbital septum" varies and requires a metrical interpretation (see p. 86). Sutura infraorbitalis is present in nearly all of our specimens except in P. C. B1 ♀, P. C. D ♀ and in the skulls from P. E. P. I and III, both male.

Apertura piriformis shows throughout our series a narrowing tendency especially in the males, and a slight diversion from this average condition in the females.

Spina nasalis anterior shows throughout an oxyacanthic development as already described in norma lateralis (p. 73).

The inferior nasal margin (incisura piriformis inferior mihi) is rather variable and gives rise to amblycraspedotic, bothrocraspedotic and oxycraspedotic conditions in the terminology of Macalister. The morphologically most advanced oxycraspedotic condition was seen in the P. C. B2 ♂ skull frequently referred to.

Fossa canina as a mark of racial importance seems to be directly dependent on the relative height of processus alveolaris. The general status of fossa canina is that of pronounced shallowness or even absence. In certain cases as in P. E. P. I ♂ and III ♂, the distinct approximation of the inferior margin of the orbit toward the frontal plane in ear–eye orientation, a condition spoken of by the present writer as "frontality of the orbit", brings about a collusional impression of fossa canina.

b. Metrical observations

The measurements in norma frontalis are in the majority those of the splanchnocranium, while only a few neurocranial dimensions, viewed in perspective, enter into the picture. The most important measurements are assembled in table 5.

The breadth measurements in norma frontalis are dominated by the facial (bizygomatic) breadth which attains averages of 141.3 mm. (132–156 mm.) and 132.8 mm. (126–138 mm.) in the sexes. The facial breadth in the males is on the average only very slightly exceeded by the cranial breadth which difference is somewhat more pronounced in the females as was shown already in the metrical discussion to norma verticalis. All the other breadth measurements range below the bizygomatic extension. Nearest to the latter is seen the bigonial breadth of the lower jaw with a male average of 111.0 mm. (99–120 mm.) and a female one of 101.3 mm. (95–115 mm.). Then follow in gradually diminishing intervals the biorbital breadth (*ec–ec*) with male and female averages of 100.7 mm. (97–107 mm.) and 98.8 mm. (95–102 mm.), and the upper facial breadth (*fmt–fmt*) with a male average amounting to 78.3 mm. (74–84 mm.) and a female one attaining 72.0 mm. (66–76 mm.). As might have been expected, the sex differences in the averages of the absolute measurements are invariably in favor of the males. The neurocranial breadth measurements, particularly those of the cranial and minimum frontal breadths as already discussed in norma verticalis (p. 64) are involved in several norma frontalis indices and will receive attention below (p. 87).

The height measurements of the face are either with or without the lower jaw. It is particularly the upper facial height [7] which in contrast to the somewhat insecure total facial height (*n–gn*) is of diagnostic

[7] N-pr, i.e., the most inferior point upon the interalveolar septum between the two middle incisors which the writer prefers to call prosthion inferius (pri) in contrast to the prosthion anterius (pra) situated upon the alveolar rim of the upper jaw as the most protruding point in the cranial midline. The corresponding points in the lower jaw would be the infradentale superius (ids) and anterius (ida).

TABLE 5

Measurements in norma frontalis.

MEASUREMENTS	MALE			FEMALE		
	Cases	Range	Average	Cases	Range	Average
Breadth						
Cranial	7	137–148	142.6	4	134–149	139.0
Minimum frontal	6	90–106	98.2	4	88–103	95.0
Upper facial (*fmt*)	6	74–84	78.3	4	66–76	72.0
Biorbital	6	97–107	100.7	4	95–102	98.8
Bizygomatic	6	132–156	141.3	4	126–138	132.8
Bigonial	6	99–120	111.0	6	95–115	101.3
Height						
Facial						
Total	7	118–136	126.4	2	114; 115	114.5
Upper	7	74–84	78.4	3	66–74	70.7
Cranial						
Basion–Bregma	6	127–143	137.3	4	123–131	127.5
Maximum (*ba–v*)	6	130–144	139.7	3	127–132	130.0
Frontal (*n–b* on *E–E′*)	6	81–91	86.7	3	78–82	79.7
Orbit						
Width (*mf*)	7	39–46	44.0	4	42–44	43.0
Width (*la*)	7	36–42	39.7	4	37–40	38.5
Height	7	34–40	36.7	4	34–40	36.8
Interorbital breadth						
Anterior (*mf*)	7	15–19	18.3	4	16–18	17.3
Posterior (*la*)	7	21–27	24.1	4	21–24	22.5
Biorbital breadth	6	97–107	100.7	4	95–102	98.8
Nose						
Width	7	21–26	24.3	3	22–25	23.3
Height	7	52–57	56.6	4	48–52	49.8
Nasal bones						
Minimum breadth	7	5–12	8.3	4	6–11	8.3
Maximum breadth	7	12–18	15.0	4	13–17	14.5
Indices						
Transverse craniofacial	6	96.4–105.4	99.4	3 (4)	92.6–95.0 (92.6–100.8)	93.9 (95.6)
Biorbitofrontal	6	81.8–94.4	89.6	4	83.8–95.4	90.5
Transverse jugofrontal	6	64.3–74.5	69.5	4	65.2–74.6	71.6
Transverse jugomandibular	5	70.0–79.1	76.6	2	73.3; 84.1	78.7
Facial						
Total	6	87.2–92.0	89.8	2	85.2; 90.5	87.9
Upper	6	51.9–57.0	55.8	3	50.0–58.7	54.0
Orbital (*mf*)	7	78.3–88.9	83.6	4	77.3–90.9	85.5
Orbital (*la*)	7	87.8–100.0	92.6	4	87.2–100.0	95.5
Interorbital (*mf*)[1]	6	15.5–19.6	18.0	4	16.8–18.2	17.5
Interorbital (*la*)	6	21.7–25.3	23.8	4	22.1–23.5	22.8
Nasal	7	37.5–50.0	43.0	3	45.8–48.1	46.9
Nasal bone (transverse)	7	38.5–66.7	54.3	4	35.3–78.6	60.1

[1] Interorbital index: $\frac{\text{Interorbital breadth } (mf,\, la) \times 100}{\text{Biorbital breadth}}$.

importance. The two facial heights for the males average 78.4 mm. (74–84 mm.) and 126.4 mm. (118–136 mm.), and for the females 70.7 mm. (66–74 mm.) and 114.5 mm. (114 mm.; 115 mm.). Both heights are naturally exceeded by the *ba–b* and the maximum cranial heights (*b–v*) showing in perspective in norma frontalis which have already been discussed in norma lateralis (p. 76). Something else is also involved in the height concept in norma frontalis, namely, the height of the forehead projectively measured between the nasion and bregma points in ear–eye cranial orientation. The sexes here show conspicuous differences with male and female averages of 86.7 mm. (81–91 mm.) and 79.7 mm. (78–82 mm.), to which measurements may further be added as showing in norma frontalis the postbregmatic elevation already treated of in norma lateralis (p. 76).

The orbital complex gives rise to a number of characteristic measurements. Following his custom the writer has accounted for two orbital width measurements involving the medial measuring points of the maxillofrontale and lacrimale. The two widths differ between themselves by about 4 mm. in yielding averages of 44.0 mm. (39–46 mm.) and 39.7 mm. (36–42 mm.) in the males, and 43.0 mm. (42–44 mm.) and 38.5 mm. (37–40 mm.) in the females. The sex differences as will be gathered from these figures amount to only one index unit. The typical sex difference in the orbital height in favor of the females is, on account of the paucity of the specimens, not brought out sufficiently in our series. The averages of 36.7 mm. (34–40 mm.) and 36.8 mm. (34–40 mm.) differ only by a fraction in favor of the females, while the ranges are of equal extension. Slightly more recognizable is the typical sex difference in the interorbital breadths where the anterior one (maxillofrontale) yields male and female averages of 18.3 mm. (15–19 mm.) and 17.3 mm. (16–18 mm.), the posterior one (lacrimale) such of 24.1 mm. (21–27 mm.) and 22.5 mm. (21–24 mm.). The interorbital breadths averages between themselves differ thus in favor of the posterior breadth by about 6 mm., while in the sexes they differ by 1 mm. or more in favor of the males. The biorbital breadths reflect the slight proportional differences which obtain between the sexes by yielding male and female averages of 100.7 mm. (97–107 mm.) and 98.8 mm. (95–102 mm.) which are thus seen to be also in favor of the males.

The nasal measurements present a sex difference of only 1 mm. in the nasal width where the males average 24.3 mm., the females 23.3 mm. from almost equal male and female ranges of 21–26 mm., and 22–25 mm. The nasal height differs typically by yielding the higher average of

56.6 mm. (52–57 mm.) to the males against the female average of 49.8 mm. (48–52 mm.). Equality again of measurement in the sexes is shown by the minimum and maximum breadth of the nasal bones with averages of 8.3 mm. in the minimum breadth, male as well as female, and 15.0 mm. and 14.5 mm. in the maximum, the ranges for the sexes covering the values from 5–12 mm. for the minimum and from 12–18 mm. for the maximum breadth in the males, and from 6–11 mm. and 13–17 mm. in the females.

Indices. All the indices expressing percental proportions between facial and cranial breadth diameters demonstrate the predominance of the latter over the former by index averages below the 100 mark.

Transverse craniofacial index. There are in this index (see also p. 65) three specimens in which the facial (bizygomatic) breadth either equals the cranial breadth as in P. V. I ♂, or exceeds it as in P. C. B1 ♀ and P. C. C1 ♂, all of which have indices either at 100 or above. Because of the bilateral expansion of the face, phaenozygy (p. 63) in these skulls is particularly evident. Although there is amongst those specimens also a female, the averages of 99.4 (96.4–105.4) for the males and 93.9 (92.6–95.0) without, or 95.6 (92.6–100.8) with the inclusion of the individual value above 100 in the females, reveal a quite distinctive sex difference. The latter is due more to the proportional difference in the facial (8.5 mm.) than in the cranial (3.6 mm.) breadths.

Biorbitofrontal index. This index because of the only mildly differing proportions between the two dimensions involved while the sexes differ in the typical way, gives rise to fairly equal averages. The male average at 89.6 (81.8–94.4) falls slightly below that of the female at 90.5 (83.8–95.4).

Transverse jugofrontal and jugomandibular indices. Both these indices are dominated by the facial breadth diameter with the consequential result of their rangings below the 100 mark. Differences between the indices reflect different general morphological and sex proportions, the latter on the basis of the physical sex differences resulting throughout into slightly higher average expressions in the females. Thus while the jugofrontal index yields a male average of 69.5 (64.3–74.5) against a male average of the jugomandibular index of 76.6 (70.7–79.1) the female averages for the same indices come to 71.6 (65.2–74.6) and 78.7 (73.3; 84.1).

Facial indices. The two indices expressing the breadth–height relations of the face either with or without the inclusion of the mandible show in both instances the tendency toward high faces and more so in

the males than the females. The averages for the facial index (with total, i.e., nasion–gnathion height) are mesoprosopic with 89.8 (87.2–92.0) for the males and 87.9 (85.2; 90.5) for the females; they lie in close proximity to the line of demarcation between meso- and leptoprosopy which latter domain as shown by the ranges is entered upon by a number of individuals. Still more closely approximated to a similar border line between meseny and lepteny are the averages of the index of the upper face (involving the nasion–prosthion inferius height diameter). Here the male average of 55.8 (51.9–57.0) is slightly, the female average of 54.0 (50.0–58.7) almost leptenic.

Orbital and interorbital indices. More outspoken are the differences in the orbital indices in consequence of the different orbital widths employed. That the maxillofrontale width has a more segregating influence is shown by the mesoconchic male and female index averages of 83.6 (78.3–88.9) and 85.5 (77.3–90.9), and the distribution of the individual index values over the meso- and hypsiconchic divisions. In contrast to this state the lacrimale widths produce only hypsiconchic index averages from totally hypsiconchic ranges. They amount to 92.6 (87.8–100.0) and 95.5 (87.2–100.0) in the sexes. The morphological sex difference of higher female orbits is brought out by both indices. The interorbital indices with either the maxillofrontale or lacrimale interorbital breadth also reflect the morphological and sexual differences already indicated by the absolute measurements involved and on the basis of which the lacrimale–interorbital index with 23.8 (21.7–25.3) and 22.8 (22.1–23.5) in the sexes outranges the maxillofrontale–interorbital index with 18.0 (15.5–19.6) and 17.5 (16.8–18.2), while the female averages fall slightly below those of the males.

Nasal and nasal bone indices. The nasal index by its averages of 43.0 (37.5–50.0) in the males and 46.9 (45.8–48.1) signifies leptorrhinic conditions. The female average closely removed to the boundary between leptorrhiny and mesorrhiny conspicuously exceeds that of the males whose nasal height exceeds that of the females while the nasal widths are alike in both sexes. The individual indices in both sexes cover only the leptorrhinic and mesorrhinic fields and there is no chamaerrhinic representation. The transverse nasal bone index although yielding in the sexes equal averages for the minimum and maximum breadths of the nasal bones produces differing index averages of 54.3 (38.5–66.7) in the males and 60.1 (35.3–78.6) in the females which thus corroborates what has been said about the morphological status of the parts involved (p. 86).

NORMA OCCIPITALIS

a. Cranioscopic observations

Contour. The cranial contour in norma occipitalis is more unobstructed than that in norma frontalis, inasmuch as morphological detail of the latter is of greater bulk in both the neuro- and splanchnocranium which in the posterior view is covered in perspective. Applying Haberer's (1898) descriptive terminology, the outlines of all the crania of our series represent the "house shape" with straight sides which are more or less distinctly flexed into the roof parts and which latter unite into a gable formation. These gables with the exception of one, P. V. I ♂, whose roof is more evenly rounded as already pointed out under norma frontalis (p. 80), form cristae sagittales of human craniomorphology. In a number of specimens the cranial walls somewhat converge downwardly and then terminate in the mastoid processes which latter in perspective rarely exceed the inferior intermastoidal outline of the occipital norma. This inferior outline is sometimes, as in P. V. I ♂, divided into two shallowly bulging halves by the strongly developed crista occipitalis externa, and it is in the same skull that the lateral contours are varied by the remarkably developed supramastoidal crests (p. 73). The relief formations upon squama occipitalis are on the whole rather weakly developed. The typically smooth upper squama is in a number of instances set off against the lower squama by indications of torus occipitalis. In such cases lineae nuchae supremae and superiores [8] do not overlap in the midline, but form at their points of junction the variable tuberculum linearum (Merkel) of lineae nuchae superiores and protuberantia occipitalis externa (Ecker) of lineae nuchae supremae. The distance between the tubercle and protuberance seems to vary in accordance with the development of the torus. The best developed torus is that of P. E. P. III ♂, the relief of which is further complicated by the occurrence of an undivided os incae. The dividing sutura mendosa (s. transversa occipitalis) fairly coincides with linea nuchae supremae and in the serration of its medial portions is exceedingly complex; in its morphology it imitates, although on a narrower basal amplitude, the complex pattern of sutura lambdoidea. In contrast to this the lateral sections of the transverse suture are rather simple, they are identical with the primary transverse incisures between the interparietal and supraoccipital parts of os occipitale (fissura occipitointerparietalis Spee). It is also in this skull that linea temporalis superior

[8] In the Nomina Anatomica 1935 (see p. 58) lineae nuchae inferior, superior and suprema are called lineae plani nuchalis, nuchalis terminalis and nuchalis supraterminalis.

forms on each side of the skull a strong ridge along the lateral three quarters of sutura lambdoides, traverses the asterion region and terminates in the strongly bulging tuberosity of processus mastoideus on its lateral side while the similarly strongly developed linea temporalis inferior continues into crista supramastoidea. The distinctly marked parallel ridges give rise to a well-developed sulcus supramastoideus. Lineae nuchae inferiores, crista occipitalis externa, and the shallow depressions which occur between the nuchal lines and the crest, all comprised in the relief formations, are, as already mentioned, on the whole weakly developed. In a few skulls however and particularly male ones, they are found somewhat more pronounced.

A certain degree of variability, as is usually the case, occurs in the size and number of foramen mastoideum. Its typical place in the occipitomastoidal suture is sometimes changed for a position medially or laterally of it and varies also as to right or left upon the cranium. Two varying instances are, e.g., those of P. V. 3cII ♀ and P. E. P. I ♂, where in the former there are two foramina laterally of sutura occipitomastoidea on the right side, the left being devoid of a foramen, while in the latter skull there are two foramina in the right suture, while in the left one a foramen of considerable size occurs.

b. Metrical observations

The diameters of height and of various breadths, assembled in table 6, are of principal account in the metrical interpretation of the cranial expanse in norma occipitalis.

The cranial height naturally differs in the sexes in favor of the males, where the average attains 135.9 mm. (127–143 mm.) while the females come to only 127.7 mm. (123–131 mm.).

The cranial breadth diameters differ similarly with 142.6 mm. (137–148 mm.) and 139.0 mm. (134–149 mm.) in the sexes. In the variants of the cranial breadth, the biauricular and bimastoidal, the sex proportion is the typical one in the former with a male average of 130.5 mm. (121–141 mm.) as against the female average of 125.8 mm. (121–130 mm.). The bimastoidal averages are alike in the sexes with 104.8 mm. from male and female ranges of 98–111 mm. and 100–112 mm.

In the indices the cranial breadth–height index yields metriocranial male and female averages of 95.4 (87.6–102.9) and of 94.1 (91.8–96.3). The breadth indices between the breadth variants and the cranial breadth proper evince the significance of the gradually diminishing biauricular and bimastoidal breadth diameters. The biauricular

TABLE 6

Measurements in norma occipitalis.

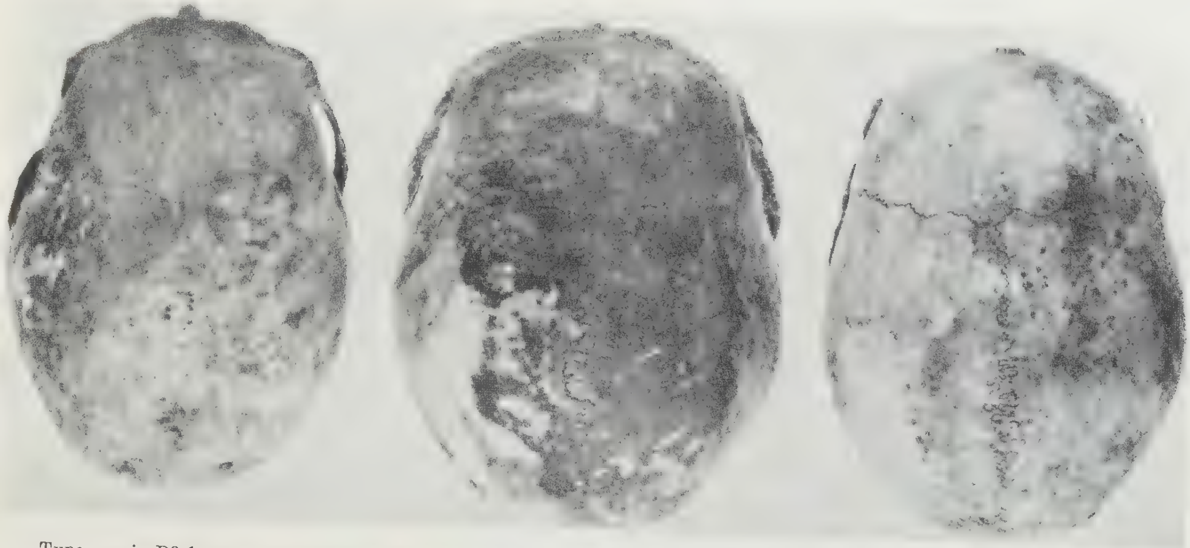
MEASUREMENTS (CRANIAL)	MALE			FEMALE		
	Cases	Ranges	Average	Cases	Ranges	Average
Breadth						
1. Cranial	7	137–148	142.6	4	134–149	139.0
2. Biauricular	6	121–141	130.5	4	121–130	125.8
3. Bimastoidal	6	98–111	104.8	4	100–112	104.8
Height						
4. Cranial	7	127–143	135.9	3	123–131	127.7
Indices						
$\frac{4 \times 100}{1}$	7	87.6–102.9	95.4	3	91.8–96.3	94.1
$\frac{2 \times 100}{1}$	6	87.1–95.3	91.3	4	84.6–94.0	90.5
$\frac{3 \times 100}{1}$	6	70.5–77.4	73.8	4	72.5–83.6	76.8

breadth–height index ranging below the cranial breadth-height index averages 91.3 (87.1–95.3) in the males and 90.5 (84.6–94.0) in the females, while in the bimastoidal breadth–height index the averages attain only 73.8 (70.5–77.4) in the males and 76.8 (72.5–83.6) in the females, in a reversed order furthermore from that of the other indices which yielded the higher averages to the males, a condition naturally brought about by the sameness in the sexes of the bimastoidal diameters in proportion to the differences obtaining in the biauricular.

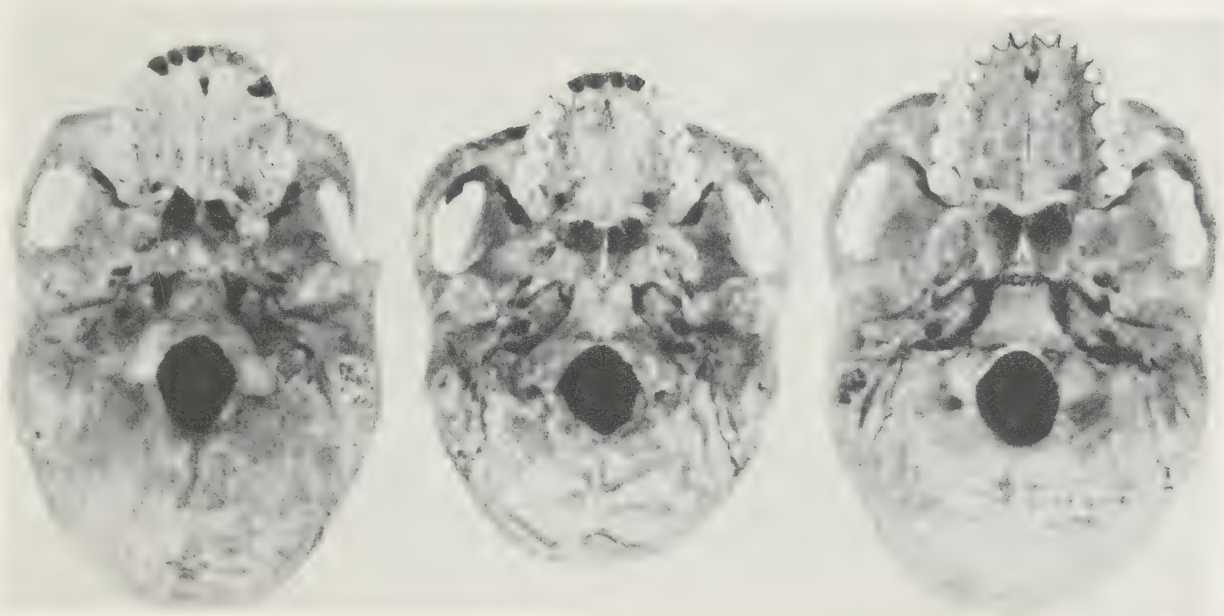
(To be continued)

Type crania B2♂ mat., C1♂ mat. and C2♂? ad., from Palutat Cave, Prince William Sound, Alaska, in norma frontalis.

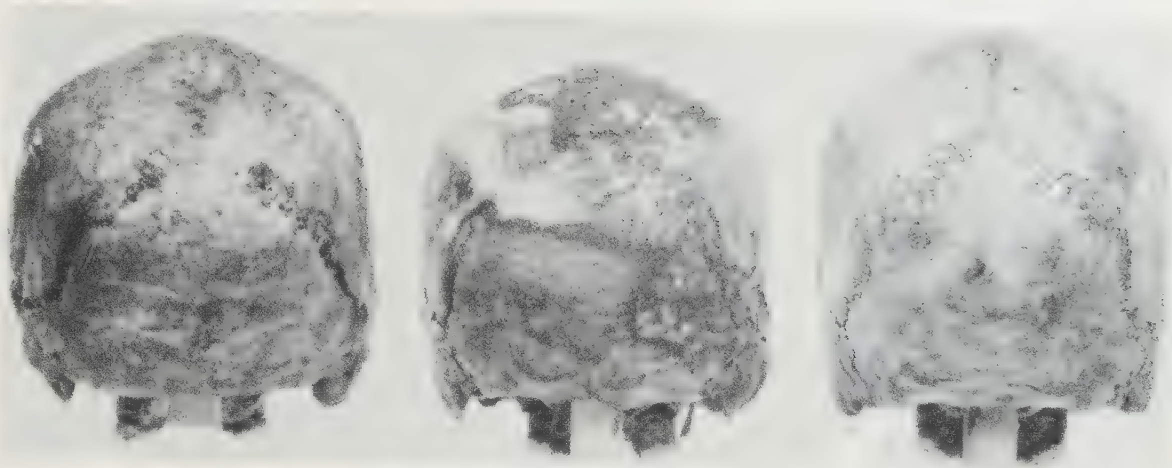
Type crania B2♂ mat., C1♂ mat. and C2♂ ad., from Palutat Cave, Prince William Sound, Alaska, in norma lateralis.



Type crania B2♂ mat., C1♂ mat and C2♂? ad., from Palutat Cave, Prince William Sound, Alaska, in norma verticalis.



Type crania B2♂ mat., C1♂ mat. and C2♂ ad., from Palutat Cave, Prince William Sound, Alaska, in norma basilaris.



Type crania B2♂ mat., C1♂ mat. and C2♂? ad., from Palutat Cave, Prince William Sound, Alaska, in norma occipitalis.

THE PARAMOLAR TUBERCLE (BOLK)

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SIX FIGURES

According to the late Prof. L. Bolk ('16) of the Anatomical Institute of the University of Amsterdam, a certain cusp known as the paramolar cusp or tubercle could appear on second and third permanent molars but never on the first permanent molar. On this premise he based his theories of human dentition which, however, are not supported by the evidence. Recently instances of such anomalies were found on the mandibular first permanent molars: (1) of a skull in the New Britain Melanesian collection at the Chicago Natural History Museum, (2) of a skull in a similar collection at the U. S. National Museum (Smithsonian Institution), and (3) in a living white female.

Bolk assumed that supernumerary teeth were atavisms and ascribed significance to all such findings. Whenever extra teeth or cusps occurred he considered them as reversions or representatives of parts of the dentitions of the past in our ancestral tree, i.e., representatives of teeth which had long since been abandoned in the evolution of the dentition. He made much of the fact that supernnumerary teeth have been found to appear buccal to and between the first and second permanent molars and between the second and third permanent molars, but never between the last premolar (second bicuspid) and the first permanent molar. He maintained that the human deciduous dentition at one time had more posterior teeth in each quadrant than it has today, but that these were lost in the process of evolution. The lost teeth were supposed to be represented in the modern human dentition by the occasional appearance of supernumerary teeth buccal to and between the molars. He believed that these teeth, which he called paramolars, sometimes fused with the adjacent permanent molars of present dentitions during development and left only a cusp on the molars as evidence of their former presence. This cusp, which is found occasionally on the anterior portion of the buccal surface of the second and third molars, is called the paramolar tubercle and is the one that is so significant in Bolk's work (fig. 1). Bolk failed to find this cusp on any of the first

permanent molars of 20,000 cases which he examined for this supernumerary element.

With this as a basis, plus the fact that the deciduous teeth develop labially and buccally to the permanent ones, Bolk presented the chart shown in figure 2. Study of the chart reveals his concept of dentition. The deciduous teeth are arranged in an arch buccal to or outside of the arch of the permanent teeth. They are located respectively in the approximate positions and relationships in which they are supposed to develop in the human jaw. He quite correctly includes the permanent

Fig. 1 Buccal surface of a permanent lower molar showing the paramolar cusp or tubercle.

first molar in the deciduous series as the third deciduous molar. However, he adds three paramolars to this series distal to the so-called first permanent molar. In the permanent series he added Pm3, a third bicuspid or premolar, which he claimed had been lost in the process of evolution and the distomolar (Di), the occasionally seen fourth permanent molar.

It can readily be seen on the chart, according to Bolk's theory, how the paramolar tubercle could appear only on the second and third molars. These two permanent molars alone have teeth buccal to them

with which they could fuse. The first permanent molar has no tooth buccal to it and hence could not in any case have a paramolar tubercle. That is, assuming as Bolk did, that such a cusp could have no other origin.

Bolk's insistence on attaching significance to all supernumerary elements, and the inflexibility of the scheme makes the finding of even one instance of a paramolar cusp in a first permanent molar a decisive

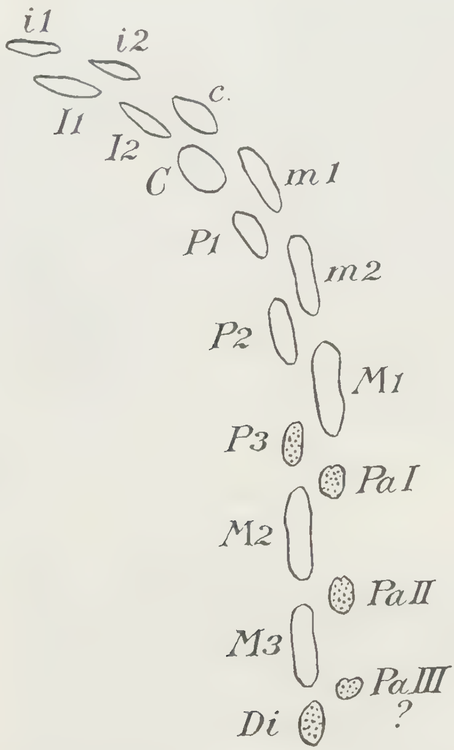


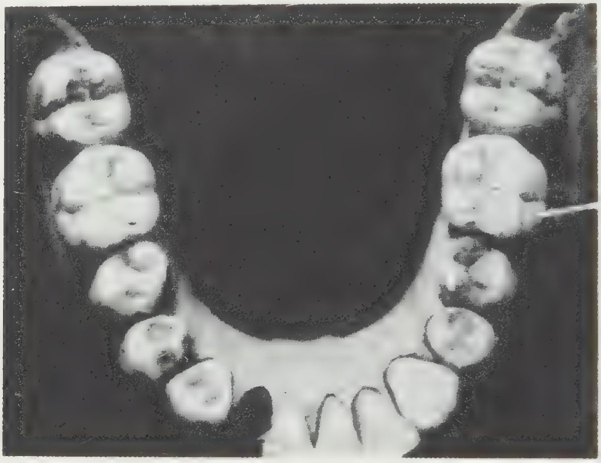
Fig. 2 Bolk's chart showing relationship of deciduous to permanent dentition. M_1 is in the outer or deciduous series of teeth in line with the commonly recognized deciduous teeth and paramolars. To the permanent series Bolk added P_3, which he claims has been lost in the process of evolution, and the distomolar, Di, the fourth permanent molar (after Bolk).

point in rejecting his theory. The finding of three makes it conclusive beyond a doubt. The three cases found are shown in figures 3, 4, and 5. In all cases the anomaly was bilateral.

Schwarz ('25) in a treatise on the morphology of Melanesian teeth and jaws mentioned finding paramolar cusps in the first molars of a

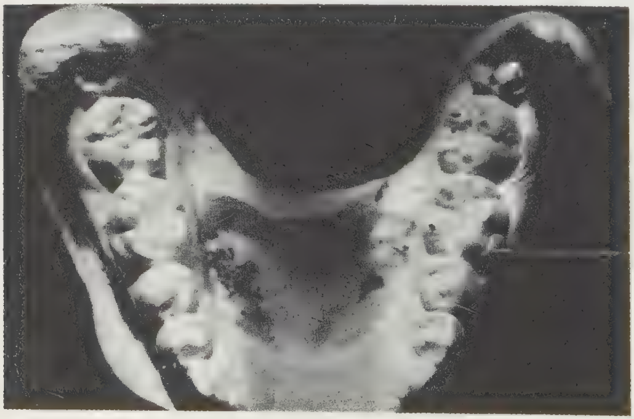
Melanesian mandible and also in a 6-year-old white boy of Basel, Switzerland.

It should be pointed out that these extra cusps appearing on the buccal surfaces of teeth are not confined to molars alone nor are they confined to man. Stehlin ('12) described a similar cusp on the upper right first bicuspid of a Paleocene primate, Plesiadapis remensis Lem.



Bolk's Paramolar Cusp

Fig. 3 Occlusal view of the mandibular teeth of a New Britain Melansian, Chicago Natural History Musum no. 43131. Both lower first permanent molars reveal the paramolar cusps or tubercles on the buccal surfaces.



Bolk's Paramolar Tubercle or Cusp

Fig. 4 Occlusal view of a cast of the mandibular teeth of a white female. Both lower first permanent molars reveal the paramolar cusps or tubercles on the buccal surfaces.

which is in the museum of Basel. Gorjanovic-Kramberger ('08) described such a cusp on the first premolar of the Krapina upper jaw D. Schwarz ('25) also found the same on two Melanesian premolars.

Besides all this the paleontological evidence is against the theories of Bolk regarding the paramolars (Gregory, '22). Nowhere in the literature of the fossil mammals is there any evidence of the permanent molars being preceded by deciduous teeth.

Fig. 5 Occlusal view of the mandibular teeth of a New Hebrides Melanesian, United States National Museum, no. 227,455. All six mandibular molars in this specimen exhibit paramolar cusps on the buccal surfaces (courtesy of Dr. T. D. Stewart, Curator of Physical Anthropology, U. S. National Museum).

The first permanent molars (both maxillary and mandibular) are less variable in pattern and have smaller coefficients of variability than the second and third molars. This "stability" is no doubt a reason for the paramolar cusp not making as frequent an appearance on the first molars as it does on the second and third molars. The fact that it appears bilaterally in the three cases presented here indicates that a genetic influence is operating and that the anomaly is probably not a result of some incidental environmental factor during development of the teeth.

Study of the buccal surfaces of human molars reveals many with a bulging in the gingival third parallel to the cervix of the tooth. From a similar bulging or cingulum in the molars of the opossum and many other animals we find extra cusps rising as seen in the drawing of figure 6. These are known as stylar cusps, and are named according to their

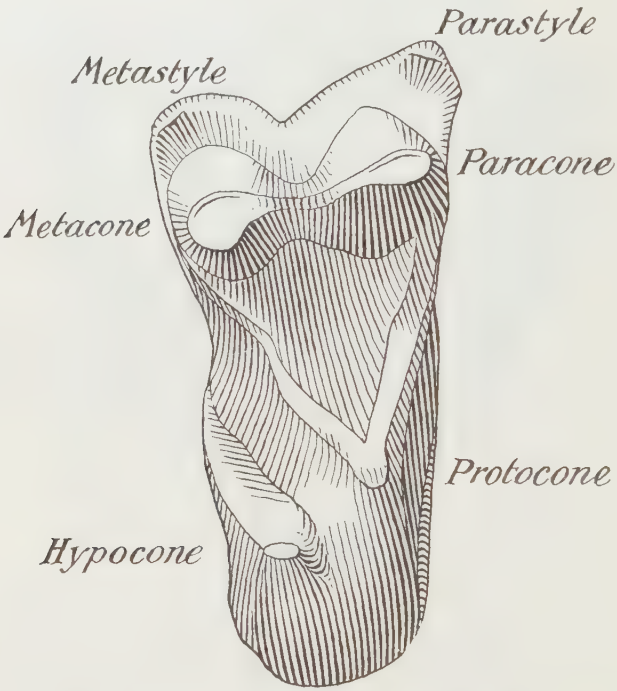


Fig. 6 Occlusal view of an upper right molar of Ictops dakotensis showing the four main cusps and two stylar cusps. P25803, Chicago Natural History Museum.

location in respect to the other main cusps of the tooth. A stylar cusp near the metacone (disto-buccal cusp) of an upper molar is known as the metastyle and so on.

Bolk's paramolar cusp, therefore, located as it is on the buccal surface of teeth in both the upper and lower jaws, should be called simply a parastyle or protostylid as the case may be and retain only the significance of a stylar cusp.

SUMMARY

Three instances of the occurrence of Bolk's paramolar cusps or tubercles on lower first permanent molars were presented in a discussion of Bolk's theories of human dentition. The appearance of these anomalies on these particular teeth was shown to be an adequate basis for rejection of the theories. Paramolar cusps are not atavisms and should only have the significance of stylar cusps.

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REVIEW

THE SCIENCE OF MAN IN THE WORLD CRISIS. Edited by RALPH LINTON. Columbia University Press, New York, XIV + 532 pp., 1945. ($4.00)

Ours is a time when synthesis of science and viewing man in its perspective are in order. The editor of this volume defines its purpose as follows: "it usually takes about a generation for the new discoveries and techniques of one science to become a part of the regular working equipment of other sciences. It takes considerably longer for such findings to become familiar to the layman and to exert any significant influence upon his thinking. The present book is an attempt to shorten this time interval." Eleven of the twenty-two contributors are anthropologists, and the others sociologists, psychologists, a geographer, and a biologist. Their essays are about as variable in style and approach as is usual in such symposia, but taken together they form a fairly integrated whole. While this is not a popular book, a thoughtful reader will find rewarding the consideration of the basic concepts as well as the positive information contained therein.

The essay of Professor H. L. Shapiro on "Society and Biological Man," places the problem of race in a broad biological and philosophical context. The plasticity of the human type, as determined by interactions of heredity and environment, is rightly stressed. However, the statement that "The growing body of general biological observation and experiment on the plasticity of organic life was itself neutralized, at least on the human level, by Weismannean interpretations and consequently had little effect on the accepted dogma on the fixity of human type" places the blame where it does not belong. The emphatic denial by Weismann of the induction of germinal variations via somatic changes did not mean a denial of the environmental plasticity of the soma. Heredity determines the response of the organism to the environment in the process of development. Heritability and environmental plasticity of a trait are not necessarily antitheses. This very simple consideration applies, of course, to physical as well as to psychic traits, and it is, perhaps, not given due weight in the otherwise very lucid essay of Professor O. Klineberg on "Race Psychology." If a trait is shown to be modifiable by the milieu, this need not mean that it is not modified by genes as well. According to Professor Shapiro, "the tendency to interpret all aspects of civilization and society as based on factors outside and beyond the genes seems only a partial explanation of an extraordinarily complex interrelationship."

Professor W. M. Krogman begins his fine essay on "The Concept of Race" with a re-assertion of the specific unity of mankind, which is necessary because this basic principle is still not accepted by everyone. Next, he outlines a race concept founded on the tenets of modern genetics, pointing out the difficulties in its consistent application to research practice owing to insufficiency of the present knowledge of human genetics. Lastly, a concise summary of the classification of the living mankind is given. The following cavils seem, however, to be necessary. Race is defined as "a sub-group of people possessing a definite combination of physical characters, of genetic origin; this combination serves, in

varying degree, to distinguish the sub-group from other sub-groups of mankind, and the combination is transmitted in descent, providing all conditions which originally gave rise to the definite combination remain relatively unaltered; as a rule the sub-group inhabits, or did inhabit, a more or less restricted geographical region.'' Now, characters of genetic origin are necessarily transmitted in descent; on the other hand, combinations of characters need not be transmitted as combinations; the conditions which gave rise to a race are mostly obscure but it may be doubted that they remain unaltered for long. Could a shorter definition, like ''races are populations differing in the incidence of certain genes,'' be more satisfactory? At least in biological taxonomy, ''race'' and ''subspecies'' are synonyms. If a distinction between ''race'' and ''stock'' is to be made at all, the latter should be a subdivision of the former, but it may be preferable to call the highest infraspecific category simply ''race group.'' It may well be doubted that ''an incipient Negroid type'' could have arisen ''via sheer random variation and combination alone, plus the resultant intensification by inbreeding.'' To be sure, these processes may, in species with certain population structures, lead to some geographic differentiation; but it is very improbable that these processes alone could create the organized systems of numerous gene differences which characterize the human race groups. Some selective mechanisms must have been involved also, and herein lie, perhaps, some of the greatest unsolved problems of human evolution.

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REVIEW

OURSELVES UNBORN: AN EMBRYOLOGIST'S ESSAY ON MAN. By GEORGE W. CORNER. Yale University Press, New Haven, Conn. xiv + 188 pp., 18 text figures and 8 plates (together containing 92 separate illustrations), bibliography, index, 1944. ($3.00)

This volume is based upon the author's Terry Lectures of 1944, the twenty-first in the series sponsored by the Dwight Harrington Terry Foundation at Yale University. Doctor Corner is a fortunate choice as a representative of embryology to interpret its facts and implications for the non-technical auditor and reader. On embryology he speaks with authority, by virtue of a long and fruitful experience as investigator and of intimate acquaintance with the activities of the world's foremost institute of embryological research, of which he is director. In embryology and cognate fields, anatomy and primatology in particular, Corner has the advantage of close association with workers who like himself are mindful of human biology in its broadest sense. His facility in presenting a technical subject in simple and accurate terms is already demonstrated, especially by the book, "The Hormones in Human Reproduction" ('42). The present volume, dealing with subject matter which must have been far more difficult to adapt for the general reader, accomplishes as effectively for embryology what the author's previous book did for another phase of the biology of man. Illustrations are of the high quality which is characteristic of productions from the author's laboratory. The style is direct and lively. Descriptive parallels drawn from familiar experience are frequently introduced as aids to the general reader. Topics are placed in their historical setting and developed in such manner that the book has added significance as a primer of scientific method. The scope of the text is indicated in the following notes on the principal contents of the three sections.

The embryo as germ and as archive. The early differentiation of the embryo and its membranes is described. Since the youngest human embryo available at the time of the writing is believed to be at about 7½ days of development, the hiatus between egg and that stage is cautiously reconstructed on the basis of information obtained from other mammals, the rhesus monkey in particular. Comparisons of man with vertebrates generally, involving both the embryo and its accessory membranes, are drawn to illustrate that "the human embryo from egg to birth is an archive in which is written the evidence of its descent as an animal, a vertebrate, an amniote, a mammal, a primate." Emphasis is accorded the functional anatomy of the placenta, as well as its phylogenetic relations. There is a spirited attack on the superstition of maternal impressions.

Prenatal fate and foreordination. This is an account of the morbidity and mortality of the embryo, a consideration of importance in view of the commonly accepted estimate that it applies to about one-third of human pregnancies. The suggested causal factors are grouped under three main headings: defects of fertilization; defects of the maternal environment; intrinsic defects (genetic and

non-genetic) of the reproductive cells and embryo. Each of the specific agencies is discussed in detail, and evidences from observation and experiment are related. Two of the cited examples of environmental agencies are of special current interest: ocular and other defects induced in the embryo by maternal infection with the virus of German measles, but resulting only when infection occurs in the early months; erythroblastosis fetalis, produced by incompatibility of an embryo possessing the Rh factor with the mother who lacks it.

The generality and particularity of man sets forth, in a new mold, two familiar themes: man is an animal, closely related to apes and monkeys; the human body is of a generalized structural pattern rather than a specialized one, hence versatile in physical capacities. Of specific interest to physical anthropologists are the generalizations on primate affinities. Considering all the available pertinent information relating to the embryo and placenta, it is shown that a natural classification into three groups is indicated: One group comprising man and the great apes, another of the monkeys (both Old World and New World), and a third represented by Tarsius. The embryological similarities which identify the relationship between man and the great apes are regarded as being closer than the similarities of the adult bodies. In the present state of information concerning the embryology of gorilla, orang, chimpanzee and gibbons, the evidences which might offer clues to the level at which the human line diverged from the main primate stem are not available. The debated place of lemurs in the phylogenetic scheme is left without a final pronouncement, but an acceptable suggestion is offered. Embryological features, at least according to the views of some workers, would remove lemurs from the order of primates. Difficulties arise if lemurs are interposed in a postulated line of descent between an ancestral insectivore type and the pithecoids. The author proposes an explanation of these embryological inconsistencies which is in keeping with the view that lemurs are only collaterally related to the pithecoid line of descent. He gives due emphasis to the hazards attending theories of relationship which are based upon too few characteristics, and claims for the embryological features only that they are useful in combination with other observations.

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REVIEW

SPEED IN ANIMALS: THEIR SPECIALIZATION FOR RUNNING AND LEAPING. By A. BRAZIER HOWELL. University of Chicago Press, Chicago. xii + 270 pp., 55 figures. 1944. ($4.00)

Observations gleaned from years of diligent research have been gathered together by Dr. Howell to illuminate the relation between skeletal and muscular morphology and animal movement. The author recognizes that the evolutionary survival of morphological variations is dependent on their physiological fitness in coping with changing environments. The fitness of the muscular and skeletal systems is determined, he believes, largely by their ability to aid in procuring sustenance and in providing adequate protection against adversaries. It is in the latter connection that speed is most essential. The selection of "Speed" as the key word in the title of the book scarcely does justice to the assiduous attention paid to other locomotor adaptations.

The value of this book to the anthropologist lies in its emphasis of the theme that the framework of the vertebrate body is largely concerned with motor function, and that many portions of it can be studied most intelligently when interpreted in terms of adaptation to this activity. Specific references to man do not loom large. In part this is due to the detached point of view of the comparative anatomist, to whom man is a vertebrate but not the vertebrate. A contributing reason is the fact that the primary trend in the motor adaptations of primates has not been towards speed, but in the direction of dissociation in function of the fore- and hind-limbs, with concomitant brachiation, prehension and bipedal posture. In the brief discussion of these factors which the scope of the book has warranted, Dr. Howell demonstrates familiarity with the more recent experimental approaches.

The evaluation of locomotor adaptation requires an intimate knowledge of the structure of the body on the one hand and of the dynamics of locomotion on the other. "Speed in Animals" reflects the interest of the author in the morphology of the locomotor apparatus and reviews in admirable detail the variations to be found in the taxonomic array of vertebrates. The correlation of these observations with a fund of information concerning the motor habits of animals leads to some useful generalizations. As one example, when the manus is used for feeding, the relative length of humerus and radius is largely determined by size of head and length of neck; when the primary adaptation is for running, the radius, as well as the tibia, tends to increase in relative length. A more precise interpretation in terms of the physics of locomotion is suggested by a general discussion of pertinent characteristics of pendulums and levers.

"Speed in Animals" provides a guide to the present state of knowledge concerning locomotor adaptation. A perusal of its pages demonstrates the extent to which the investigation of structure has outstripped the study of function. To make our understanding of animal movement equal to that of structure, movement must also be dissected, or analyzed, into its dynamic components. The

experimental methods for such analyses have been developed. It is to be hoped that Dr. Howell's book will prove a stimulus to further application of these methods, so that a more intimate analysis of function may lead to a more thorough appreciation of form.

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THE SIZE AND PROPORTIONS OF ADULT MIDGETS [1]

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ONE PLATE

INTRODUCTION

Throughout the long history of man there have appeared individuals who were smaller than the accepted norm for the population to which they belonged. These dwarfs and midgets seem to have caught the public imagination and they have been regarded as curiosities since the dawn of history. The earliest recorded stature of a dwarf is that of Khoumhatpon in the sixth (VI) Egyptian dynasty (2500 B. C.). He is remembered as the superintendent of royal linen, an office of wealth and importance.

During the period of the prosperity of Rome, a dwarf was a part of the establishment of every noble family.[2] Julia, the daughter of Augustus Caesar, and Mark Antony both owned dwarfs. Later, during the decline of the Roman Empire, there was much traffic in dwarfs. Many attempts were made to produce dwarfism in well-formed infants by means of bandages and instruments designed to retard development. The fashion of dwarfs at court was revived in the 16th Century and even Catherine de Medici tried to produce a dwarf race by causing marriages to be celebrated between male and female dwarfs.

There are many accounts of dwarfs and midgets some of whom played important roles in their days. One of the most celebrated was Jeffrey Hudson (b. 1619) who figures prominently in "Peveril of the Peak" of Sir Walter Scott. Hudson, when presented by the Duchess of Buckingham to Henrietta Maria, the wife of King Charles I, was reputed to be scarcely 18 inches tall. He grew later to a height of 3 feet, 9 inches. He carried out certain commissions for the queen and even fought a duel and killed his man. In 1679 he was sent to the Gatehouse, Westminster, charged with complicity in the popish plot. He died at the age of 63 years while still on royal pension. There are portraits of him at Hampton Court and Buckingham Palace.

[1] This paper is a condensed version of a portion of a thesis submitted to Harvard University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Much of this historical material is taken from the monograph "Dwarfism" by H. Rischbieth ('12).

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Perhaps the best known dwarf of recent times was "General Tom Thumb" (Charles Stratton, born 1832). It is claimed that he never attained a stature of more than 21 inches, and as such was heralded as the smallest man of his day. Phineas T. Barnum, the great showman made more than one fortune by exhibiting Tomb Thumb and his wife who was one of the original Warren sisters. The dwarf couple had one child of normal size and proportions, which died in infancy.

During the early nineteen hundreds dwarfs began to be exhibited in large numbers in various countries and travelled from place to place as regular theatrical troupes. In this country the Singer Midgets have become very well known. The Ritter troupe in Germany and the Roper troupe in England have travelled extensively, and from all reports the members of these groups are talented performers.

MATERIAL

Anthropometric data on midgets are rare. Most of the accounts in the literature deal with descriptions of isolated cases or, at the most measurements on a very few cases done more or less at random without any attempt to analyse the data collected. Some of these measurements have been made on the living and some on skeletal material. In no instance has any investigator taken anthropometric measurements on a large series of midgets. Information as to the variability of midgets has, therefore, been practically non-existent.

The opportunity to make such a study presented itself to the author at the Chicago World's Fair. This paper presents the results of an anthropological investigation on a large group of midgets and it is hoped that it will furnish data which will aid future research in this field.

At the Century of Progress Exposition in Chicago during the summers of 1933 and 1934 there was established as a concession in the amusement area a Midget Village. In this village were assembled over a hundred midgets and dwarfs from different parts of the world who were on exhibition for all to see who had the price of admission. Most of these small people were members of theatrical troupes under contract to appear at this Midget Village for the duration of the World's Fair. There were dancers, acrobats, singers, and musicians who took their turn on the various stage programs. Other members of the village were hired as "atmosphere" and paraded about dressed as policemen, firemen, candy and ice-cream salesmen, and officials of the Midget Village. One hundred "citizens" of the Midget Village were measured. Most of these were midgets, that is, ateleiotics. Seven were achondroplastics. Six were children of midget parents.

The present study reports the measurements and observations on fifty-three white male midgets and thirty-one white female midgets. For comparative material the same measurements and observations were taken on 198 school children of both sexes between the ages of 5 and 8 years, and on 322 normal adult males and 348 normal adult females. The two groups of adults represent random samples from much larger series measured by the author at the Harvard University Anthropological exhibit in the Hall of Social Science at the Chicago World's Fair.

The comparative series of children were measured in Chicago and New York public schools. They represent random cross sections of typical American children taken without regard to ancestral background. It was not possible at the time to obtain data of national origin for these children and for that reason it was felt that these series and those of the normal adults would have to stand as random samples of American people and as such could be used for comparison with the midget series which in itself was unselected and represented a mixture of several different national extractions.

Of the fifty-three male midgets used in this study, fourteen, or 26.4% were born in the United States of native parentage, seventeen, or 32.1% were native born of foreign parentage, and twenty-two, or 41.5% were foreign born. By far the largest number of this latter group were born in the combined countries of Germany, Austria, and Hungary. Three came from Poland and one each from England, Portugal, Italy, and Russia.

Among the thirty-one female midgets, ten or 32.3%, were native born of native parentage, two or 6.5% were native born of foreign parentage, and nineteen or 61.3% were foreign born. As with the males, the great majority (11) of the foreign-born females came from Germany, Austria, and Hungary. Three were from Great Britain, two each from Poland and the Balkans, and one from Italy.

There are no available figures as to the national or racial frequency of midgets, but with information gathered from managers of midget troupes it seems logical to assume that no one country has a monopoly on the occurrence of these tiny people. One manager made the remark that most midgets like to be 21 years old, 30 inches tall, to weigh 40 pounds, and to be born in Budapest. Another claimed that the reason so many of the theatrical midgets came from central Europe was because their families did not want them and sought to put them on exhibition in order to make some money for family support. He claimed that there are probably more midgets in this country than any other place, but that

here the families tend to keep them at home and do not allow them to go on the stage. It is claimed that there are at least forty midgets in Chicago alone.

SOCIOLOGICAL DATA

Age

The figures obtained for age of these midgets were probably accurate in the main, but there were some obvious discrepancies, especially in the female series. For males, the mean age was 31.8 years, and for females 40.6 years. The range for the former group was 18–74 years and for the latter 18–84 years.

The corresponding figures for mean age of the comparative sample of normal adults was as follows: males 33.0 years and females 30.6 years. The range for these adult male and female series were 15–84 and 15–79 respectively.

Ages of the control samples of children were based on their last birthday. All boys in the 7-year-old group, for example, had already passed their seventh but had not yet reached their eighth birthday.

Marital state

Midgets do not appear to be of the marrying kind since only 20.7% of the males and 22.6% of the females had taken marriage vows. Two of the males were widowers and one admitted being divorced.

Being in the travelling show business may in part account for the high percentage of celibacy. Also it is probable that some of the marriages were performed as publicity stunts, as, for example, when a midget man or woman married a normal full-sized adult, or even when a male midget married a fat lady in the circus.

Most midget marriages result in few, if any, offspring. The cases of a midget father and mother having normal children are very few, and still rarer is a midget child resulting from such a union.

Offspring

Eleven children was the total for all the male midgets who were or had been married. This averages one child per married male midget. These figures are misleading, however, since six of the eleven married male midgets had no children. Two of the eleven had one child each, two had two children and one had five. Most of the children resulted from marriages between midgets and normal-sized women.

Four of the seven married women midgets had no children, one had one child, one had four, and one had six. The six children of this last marriage were all normal-sized and the father was a normal adult. The same was true in the case of the marriage which resulted in four children.

Siblings

Both the male and female midgets came from medium-sized families. The total number of brothers and sisters in the case of the males was 212, which gives an average of four siblings per midget. The thirty-one females had a total of 117 brothers and sisters averaging 3.8 siblings per midget. The range for number of brothers and sisters was 0–11 for males and 0–10 for females.

In this series there were four sets of brothers and sisters. Two of the female midgets were sisters, and two of the male midgets were brothers. In addition there was one set of male midget twins, and one male and one female were brother and sister.

Education

The educational attainments of the midgets is of especial interest. Over 75% of the males claimed to have had some high school or college training. This is rather amazing when one considers that most of these people had been in show business since their youth and did not have much opportunity to carry on their schooling. About 22% of the females received most of their education in the home with private or home instruction. One young man had already finished college and had recently been studying for his master's degree.

Reports vary as to the mental ability of midgets. Managers of midget troupes and other persons who have observed these little people over long periods of time generally agree that they are quite up to normal standards for their respective ages. There are no available data on the I. Q. of midgets, but it seems quite probable that taking their environmental situation into consideration one would find all the gradations from subnormal to above average so far as their mental ability is concerned. The mental achievement of a midget is difficult to evaluate in terms of standards for fully grown adults living normal lives. It must be remembered that midgets, whether in show business or not, when in public are always on exhibition. They are very sensitive people, quite cognizant of the fact that theirs is a strange and artificial life. They live in a world not made for them and therefore they must adapt them-

selves to an adverse environment. They are handicapped from the very start, but in spite of this they have done remarkably well in many instances. Of course, the individuals in this group may not represent a true cross section of all midgets. Nevertheless, these people who had gone into show business showed great ability as entertainers. Many had learned to play musical instruments, some were proficient tap and ballet dancers, while others were comedians, acrobats, or singers. One of the very tiniest members of the Midget Village was learning to play the xylophone in his spare time.

General health

No accurate data has been collected concerning the general health of midgets, but indications suggest that they are perhaps above average in this respect. Managers of midget troupes universally agree that their charges have given them little or no worry so far as their health was concerned. One manager had travelled 9 years with ten midgets and never had to have a doctor. Other managers have travelled all over Europe, South Africa, and the Americas and had never had any serious illnesses reported among their protegees. Still another remarked that the only trouble he had with his midgets was in connection with their teeth. It was his experience that the midgets in his care had to have frequent dental attention because of excessively crowded condition of the teeth.

An attempt was made in this study to observed the dentition, but most of the midgets seemed to be very sensitive about their teeth and consequently were not cooperative when it came to a dental examination. Enough data was collected, however, to suggest that there was considerable retardation in the erruption of the permanent teeth. In many cases the deciduous teeth persisted well up into the late teens and in some instances the permanents were still errupting up to the age of 30 years. A large majority were troubled with excessive crowding as if the teeth were too large or too many for the jaws.

"TRUE MIDGETS" AND "MINIATURES"

During the analysis of the data it was found that there was considerable variability in body and head form within the series. The ranges of the measurements and the standard deviations were so large in some instances as to suggest that there was more than one type of midget represented.

Since photographs had been obtained of all these subjects, the attempt was made on the basis of these pictures alone to divide up the series

into groups, all members of which appeared to possess similar morphological characteristics. In most instances it was fairly easy to differentiate between individual types, but a few cases were more difficult to place. These, however, finally were assigned to one group or another after careful analysis of the less obvious differences.

Among the fifty-three male midgets and thirty-one female midgets there appeared to be at least three very distinct types. The first type, of which there were only two examples, were the two smallest midgets in the male series. A female of the same variety was on exhibition in the Midget Village, but it was not possible to obtain her measurements. Quite recently it was my good fortune to measure and photograph another female of this type at the Presbyterian Hospital in New York City. The impression is gained that this type is extremely rare as compared to the other varieties of midgets. This type has been called "fetal-like midgets."

This first group is characterized by exceptionally short stature and pronounced infantile-like features. In stature and weight they fall far below the range of the general run of midgets and as individuals they exhibit definite mental as well as physical retardation. Although in their late teens, these people appear to be only 3 or 4 years old and to have a mentality equal to the 6- or 7-year-old level. They have to be cared for much like small children. They are often carried about and have to be helped to dress themselves and to eat their meals. This helplessness and necessity for care may account for the fact that very few of this type are on public exhibition.

These very tiny midgets have short, broad, fetal-like faces. The midfacial region is very undeveloped and the nose is small and infantile in appearance. Individuals of this type are inclined to be chubby and to possess rather delicate bones and little development of musculature. Sexually they are extremely immature and it is probable that this type never does reach a high degree of maturity, either morphologically or psychologically. Nothing is known about the life-span of this type or whether they ever grow larger at latter periods during their lives as do certain other midgets.

The second type which was called the "true midget" possesses features which are always associated with the typical circus midget. Correlated with the short stature are certain unmistakable characteristics which differentiate them from the third type which has been given the name "miniature" in this study. The "true midget" has the short, broad face of the infant, often displaying the "pekingese" appearance which seems to typify ateleiosis in many forms of the higher animals.

An almost universal characteristic of this group is the possession of very fine lines over the cheeks and around the eyes, a phenomenon associated clinically with pituitary disturbances. Most of these "true midgets" look much older than their chronological age. In general body build they run the gamut from the soft, round, poorly muscled types, to the long, thin, asthenic-looking individuals. Another variant type of this group is more rugged with sturdier skeletal structure and showing more highly developed musculature.

The third variety of midgets which has been called "miniatures" presents a somewhat different morphological picture. This group has been so named because they appear to be small editions of the normally developed adults of the species. Their faces have more mature proportions, and from the photographs, if the stature were not known, they would easily pass for normal types. The features are regular and the nose is for the most part well developed in the root and bridge. In body build they resemble normal adults more closely, although certain proportions still suggest the child rather than the adult. In both sexes, the "true midgets" are slightly more numerous than the "miniatures".

Again it must be emphasized that these types are convenient designations based on morphological features, especially of the head, as observed in the photographs. At present there seems to be no universal agreement concerning the varieties of ateleiosis. It is possible however, that with a combination of anthropological, endocrine, and x-ray studies we may eventually arrive at a useful and meaningful classification of these abnormal individuals.

In the original study the measurements taken on midgets were compared to those of young children of approximately the same stature, and also of normal adults of both sexes. The object of this procedure was to establish the position of the midgets so far as size and maturity are concerned in the range of average human growth patterns. The results indicated that for this series the male midgets were more like 7-year-old boys, and the female midgets were more like 6-year-old girls in the majority of the body and head dimensions. The body and head proportions, however, indicated that all midgets exhibit a complexity of patterns in general body growth and developement. In certain parts have retained infantile aspects and proportions, whereas in other parts they seem to have developed to a far greater degree of maturity.

For this report it seemed best to present only certain statistical constants for the midget series and to offer as controls only the 7-year-old boys and 6-year-old girls and the adult series of men and women. Tables 1 and 2 present the ranges, the means with their probable errors, and

TABLE 1

Measurements and proportions of male midgets and control groups of boys and adult males.

	MALE MIDGETS (53)			7-YEAR-OLD BOYS (23)			MALE ADULTS (322)		
	Range	Mean and P.E.	S.D.	Range	Mean and P.E.	S.D.	Range	Mean and P.E.	S.D.
Stature	78–142 cm.	123.95 ± 1.14	12.35	115–136 cm.	123.76 ± .74	5.24	152–199 cm.	173.43 ± .25	6.69
Weight	23–117 lbs.	70.00 ± 1.74	18.75	42–73 lbs.	54.24 ± 1.06	7.52	101–260 lbs.	155.70 ± .83	22.00
Span	72–146 cm.	123.50 ± 1.34	14.00	111–140 cm.	123.16 ± .91	6.44	149–202 cm.	177.72 ± .30	7.80
Biacromial diam.	17–34	27.38 ± .30	3.26	23–29	26.48 ± .19	1.34	31–54	38.06 ± .08	2.25
Chest breadth	14–29	21.57 ± .27	2.93	17–23	19.13 ± .15	1.07	23–40	28.38 ± .09	2.37
Chest depth	13–23	17.38 ± .21	2.32	13–15	14.30 ± .09	.62	16–31	22.02 ± .08	2.00
Sitting height	44–79	65.88 ± .59	6.33	63–74	68.35 ± .38	2.70	81–104	92.26 ± .14	3.60
Relative span	92–106%	99.52 ± .29	3.01	94–103%	98.52 ± .34	2.43	90–111%	102.44 ± .09	2.40
Rel. shoulder breadth	20–25	22.11 ± .10	1.06	20–23	21.35 ± .11	.81	18–25	21.98 ± .03	1.22
Thoracic index	60–91	80.88 ± .48	5.20	65–82	74.70 ± .58	4.10	57–104	77.38 ± .24	6.32
Rel. sitting height	48–59	53.51 ± .22	2.40	53–57	55.09 ± .17	1.21	48–57	53.24 ± .05	1.36
Head length	151–198 mm.	176.78 ± .76	8.25	171–192 mm.	179.24 ± .69	4.90	167–214 mm.	195.36 ± .28	7.32
Head breadth	131–160	147.18 ± .62	6.69	136–151	141.52 ± .55	3.88	132–170	154.42 ± .22	5.94
Head height	103–138	117.50 ± .66	7.12	110–132	122.17 ± .77	5.45	110–145	128.22 ± .21	5.60
Min. frontal diam.	82–109	98.38 ± .53	5.74	92–111	98.96 ± .49	3.48	93–120	106.58 ± .18	4.72
Bizygomatic diam.	102–143	123.04 ± .77	8.31	108–133	117.90 ± .75	5.36	120–159	140.70 ± .21	5.55
Bigonial diam.	74–109	92.50 ± .65	7.04	81–100	88.26 ± .68	4.81	90–129	106.98 ± .21	5.52
Total face height	69–122	97.00 ± .88	9.54	92–106	98.35 ± .53	3.80	105–144	122.85 ± .24	6.40
Upper face height	38–67	54.36 ± .53	5.74	52–63	57.22 ± .43	3.03	55–79	67.55 ± .17	4.45
Nose height	24–53	41.40 ± .51	5.52	38–45	41.87 ± .28	2.00	40–67	53.50 ± .14	3.76
Nose breadth	20–39	30.72 ± .31	3.38	26–35	29.09 ± .27	1.95	28–48	35.87 ± .11	2.82
Cephalic index	75–92%	83.46 ± .36	3.86	74–86 %	78.96 ± .46	3.24	68–94%	79.05 ± .14	3.81
Length height index	56–75	66.32 ± .32	3.48	63–74	68.26 ± .41	2.94	58–75	65.75 ± .12	3.15
Breadth-height index	68–87	79.84 ± .37	4.02	78–93	86.35 ± .54	3.87	67–96	82.94 ± .16	4.26
Fronto-parietal index	61–74	66.76 ± .28	3.04	65–74	70.09 ± .28	1.97	60–80	69.07 ± .11	2.97
Cephalo-facial index	70–91	82.98 ± .40	4.28	78–88	83.43 ± .41	2.89	82–99	91.10 ± .11	3.00
Zygo-frontal index	70–95	80.53 ± .45	3.93	80–89	83.91 ± .35	2.48	68–87	75.74 ± .12	3.12
Fronto-gonial index	81–110	93.68 ± .54	5.80	83–100	89.26 ± .60	4.27	85–114	100.35 ± .21	5.70
Zygo-gonial index	68–87	75.36 ± .36	3.95	68–81	74.83 ± .40	2.82	66–89	75.94 ± .14	3.72
Facial index	68–95	78.84 ± .51	5.54	75–90	83.61 ± .47	3.31	70–109	87.35 ± .19	5.15
Upper face index	35–54	44.47 ± .34	3.73	45–54	48.57 ± .35	2.46	37–57	47.90 ± .12	3.33
Fine hair texture		51%			13%			12%	
Eyebrow thickness submedium		47%			9%			2%	
Eyebrow concurrency absent		45%			0%			3%	
Eversion of lips submedium		43%			4%			17%	
Ear lobe size pronounced		72%			26%			32%	
Temporal fullness pronounced		68%			17%			41%	

TABLE 2

Measurements and proportions of female midgets and control groups of girls and adult females.

	FEMALE MIDGETS (31)			6-YEAR-OLD GIRLS (26)			FEMALE ADULTS (348)		
	Range	Mean and P.E.	S.D.	Range	Mean and P.E.	S.D.	Range	Mean and P.E.	S.D.
Stature	98–139 cm.	118.52 ± 1.12	9.23	108–128 cm.	117.46 ± .64	4.82	143–184 cm.	161.91 ± .23	6.42
Weight	33–133 lbs.	65.70 ± 2.45	20.20	36–59 lbs.	47.38 ± .84	6.39	91–270 lbs.	128.10 ± .71	19.70
Span	89–145 cm.	118.10 ± 1.31	10.80	103–123 cm.	115.27 ± .69	5.20	143–184 cm.	161.76 ± .26	7.14
Biachromial diam.	21 30	26.30 ± .26	2.12	23–27	25.23 ± .14	1.09	28–39	34.16 ± .06	1.80
Sitting height	56–77	64.18 ± .49	4.02	61–73	65.92 ± .34	2.54	75–95	86.65 ± .12	3.33
Relative span	94–105%	99.45 ± .36	2.86	94–104%	98.08 ± .29	2.23	94–107%	99.86 ± .09	2.50
Rel. shoulder breadth	19–28	21.84 ± .15	1.25	20–23	21.50 ± .09	.69	16–25	21.15 ± .04	1.16
Rel. sitting height	48–63	54.22 ± .36	2.96	54–58	56.08 ± .13	.95	46–59	53.56 ± .05	1.42
Head length	157–188 mm.	170.82 ± .89	7.35	158–187 mm.	172.74 ± .84	6.34	167–202 mm.	185.34 ± .23	6.24
Head breadth	132–161	143.35 ± .88	7.23	129–152	138.69 ± .70	5.29	132–164	148.15 ± .18	4.89
Head height	100–123	108.96 ± .72	5.96	107–128	115.96 ± .72	5.47	106–137	121.18 ± .20	5.40
Min. frontal diam.	85–108	96.82 ± .58	4.76	90–103	96.62 ± .45	3.39	93–116	102.94 ± .14	3.84
Bizygomatic diam.	105–132	118.39 ± .70	5.79	105–125	115.15 ± .58	4.38	120–154	132.25 ± .17	4.75
Bigonial diam.	76–99	88.02 ± .70	5.82	81–93	86.65 ± .45	3.43	86–113	98.82 ± .17	4.80
Total face height	78–107	92.34 ± .85	7.02	85–103	94.12 ± .56	4.22	95–134	113.35 ± .21	5.90
Upper face height	42–65	52.30 ± .59	4.90	50–62	55.77 ± .38	2.86	50–79	63.80 ± .15	4.05
Nose height	30–53	40.62 ± .61	5.04	35–48	40.92 ± .37	2.77	40–63	50.15 ± .13	3.56
Nose breadth	24–33	29.18 ± .31	2.54	26–31	28.35 ± .21	1.60	25–42	32.54 ± .08	2.25
Cephalic index	77–92%	83.94 ± .47	3.92	73–90 %	80.23 ± .62	4.68	71–91 %	80.04 ± .13	3.66
Length-height index	56–75	63.88 ± .55	4.58	60–78	67.58 ± .55	4.15	55–78	65.30 ± .11	3.03
Breadth-height index	68–85	75.78 ± .49	4.06	76–91	83.65 ± .53	3.98	70–96	81.86 ± .15	4.17
Fronto-parietal index	60–81	67.81 ± .48	3.98	65–77	69.69 ± .39	2.94	60–77	69.61 ± .10	2.88
Cephalo-facial index	73–93	82.88 ± .52	4.26	78–87	83.27 ± .37	2.77	79–96	89.21 ± .10	2.76
Zygo-frontal index	74–91	81.81 ± .49	4.03	77–90	84.04 ± .46	3.48	68–95	78.02 ± .11	3.16
Fronto-gonial index	80–106	91.08 ± .70	5.80	84–99	89.85 ± .49	3.74	85–119	96.15 ± .19	5.15
Zygo-gonial index	67–82	74.00 ± .43	3.57	69–81	75.23 ± .39	2.94	66–86	74.68 ± .11	3.06
Facial index	71–88	77.92 ± .60	4.92	70–91	81.88 ± .56	4.23	75–99	84.30 ± .21	5.90
Upper facial index	37–50	44.39 ± .40	3.31	42–53	48.50 ± .32	2.45	40–57	48.14 ± .12	3.24
Nasal index	60–89	72.44 ± 1.01	8.38	62–80	69.46 ± .64	4.83	48–91	65.38 ± .22	6.20
Fine hair texture		48%			38%			21%	
Eyebrow thickness submedium		47%			9%			10%	
Eyebrow concurrency absent		52%			15%			14%	
Eversion of lips submedium		23%			4%			9%	
Ear lobe size pronounced		74%			8%			27%	
Temporal fullness pronounced		61%			42%			54%	

the standard deviations for these several groups. In these tables all the midgets are considered together regardless of type. The tables also include certain characters which were observed to occur more often among the midgets than among the controls. These characters have been regarded as more or less typical and perhaps unique for the midget groups. That there is a considerable range of growth achievement is clear from the above, but one can never be sure, at the time of measurement, that size is permanently fixed. For it is well known among people who have observed the growth of midgets that some of them suddenly begin to grow between the ages of 25 and 30 years, and that some of the very small ones who were making big money in exhibitions have literally "grown themselves out of a job".

The shortest stature for this series of midgets of either sex was that of a young man 18 years of age. His height was 78 cm. or 30.5 inches. This was 20 cm. shorter than the tiniest female midget whose height was 98 cm. or about 38.5 inches. There has been much controversy as to what is the smallest recorded stature for midgets. Some claims go as low as 18 inches or even less. It is very hard to believe these figures, and one should not take for granted that reports in the literature are always correct. Even the alleged height of 21 inches for "General Tom Thumb" probably was a publicity figure.

DISCUSSION

Unfortunately it was not possible to obtain endocrine studies or radiographs on any of the midgets, and the genetic studies which were contemplated by another investigator never materialized. This study, then, resolved itself into a presentation of anthropological data which were gathered on the series of midgets and the controls. No attempt was made to inquire into the genesis or conditioning of any of the subjects. They were arbitrarily accepted as accredited ateleiotics because they were "very diminutive persons of 'normal' proportions."

In normal growth and development, chronological age correlates well with the processes of maturation. Students of human constitution have found, however, that in many cases individuals appear to be younger or older than their chronological age. This holds true for all phases of the total personality including the morphological, the physiological, and the emotional and psychic aspects of the organism. The same phenomenon is found in midgets, of course, but to an even more pronounced degree. Midgets of both sexes average as old or older than the compared samples of adults, but they are in no sense as mature as the adults, if by maturity we mean the completeness of growth and develop-

ment brought about by natural processes. This completeness must necessarily refer to the attainment of full size and strength as well as mental and emotional vigor of the organism as observed in normal growth. A midget may attain full maturity so far as midget standards are concerned, but this may be far below the maturity as measured on the scale of healthy full-grown adults.

Perhaps the most outstanding result of this study has been the discovery that midgets as a group vary enormously in the degree of maturation of various parts of the body as revealed in the comparisons of their body proportions with those of the children and adults. In general, it would appear that the midgets are more like the children in head proportions, but resemble the adults in the relationships of the various body segments. A more complete and detailed anthropometric study coupled with x-ray studies might enable one to place the midgets fairly accurately in the maturity scale for every part of the body. The present report can merely show tends.

Midgets appear to occupy an intermediate position between the children and adults, but rather closer to the latter group in the matter cf body growth and development. Apparently those factors which are responsible for the retardation of growth in ateleiosis do not concurrently govern the processes of maturation, which in ''normals'' is very closely correlated with age. Although the stature of the midgets averages about the same as that of the compared children's groups the proportions of the body are quite dissimilar. Whereas young children possess relatively great sitting heights and narrow shoulders, midgets display relatively low sitting heights and relatively broad shoulders like the adults. Midgets are unlike either the children or adults, however, in possessing relatively deep thoraces. Whether this deep-chestedness of the midgets is a unique character or simply another evidence of the disharmonies in growth and development processes is open to question. In general the evidence seems to point to more mature relationships of the various parts of the midget body than is found in that of the child. In the course of the development of the midget body the arms do not appear to have kept pace with the legs. Whereas the legs relative to stature have attained adult proportions, the arms have lagged behind so that the mean relative span index for midgets, for example, is closer to that of the children than that of the adults.

Although there are certain differences in the racial composition of the groups compared, the differences which obtain between midgets and children on the one hand, and midgets and adults on the other, are of such a character as to suggest that in head and face proportions these

small people again fall into an intermediate position as compared to the control groups. There is evidence also that the various parts of the head and face show the same types of discrepancies of growth and development as were found in the body.

Midgets are characteristically low-headed, and with this low-headedness a pronounced brachycephaly is often found. The great breadth of the head begins well foreward and is carried back and upward over the parietal bones. The forehead, however, is narrow in relation to the extreme breadth of the head. In proportion to facial breadth the forehead is wider than in children, but narrower than in adults.

The lower part of the midget face is relatively broader than the forehead. This is not the case among average children. Relative to facial breadth, however, the midget bigonial diameter does not deviate appreciably from any of the control groups.

The most striking differences between midgets and the compared groups of children and adults are found in the relative height-breadth proportions of the face. Midgets have characteristically short, broad faces as compared to the "normals." Here is probable evidence of a lagging behind in growth and development of the midget face, and a retention of more infantile proportions. It is only in the general facial contours and structure, however, that this infantile appearance is particularly noticeable. Midgets as a rule have well-developed noses. Both the bridge height and the root give to the nasal profile and tip a much more mature aspect than is found in the children used for controls. Again, in the midgets, the brow ridges are more pronounced than in the children, and contribute a sense of greater maturity and development in this facial area.

There are certain other characteristics of the face and head which are found in a large percentage of midgets and appear to be more or less unique for this group. Among these may be noted: thin lips which show very little of the membranous portion; fine hair texture; scanty eyebrows with little or no concurrency; bulging temporal regions; and large ear lobes. Judging from the photographs, the ears also appear to be large and set low on the head, and the upper lip long and convex in profile. The naso-labial grooves are conspicuous as are also the vertical grooves over the glabella region.

The general morphology of the body indicates that many different types of build are represented among the midgets. On a structural basis most of them seem to lack a well-developed muscular system and consequently they appear to be soft and pudgy. Their figures, as a rule, are not shapely according to normal standards. The muscle contours are

poor and the whole body seems to be bathed in a more or less thick layer of fat. Extreme linearity of physique is rare among these people.

It has not been within the scope of this report to discuss the etiology of midget conditions. In general it may be stated that investigations of the cause of the midget state, especially the more recent studies, have been concerned with disturbances of function or pathological changes in one or more of the endocrine glands, particularly the pituitary. But as yet, notwithstanding a large amount of work in this field of hormone research, no significant disclosures have appeared. That the hormones may play their part is probable, but genetic and intrauterine factors may likewise contribute to the production of midgets. The anthropologist can furnish much valuable information on this problem by demonstrating the presence and nature of morphological differences encountered in these small people.

SUMMARY

1. The results of an anthropometric study made on fifty-three adult male and thirty-one adult female midgets are presented. The midgets were measured in the Midget Village at the Chicago World's Fair.

2. By inspection of the photographs it was found that the series could be divided up into three morphological groups. These were called "fetal-like midgets," "true midgets" and "miniatures." The characteristics of these three groups are discussed.

3. The sociological data revealed that few of these diminutive people ever marry or, if married, produce few offspring. They come from medium sized families and their mentality and educational achievements seem to be on a par with normal people. Their general health is exceptionally good. Many cases of retardation of permanent teeth erruption were noted.

4. The anthropometric data of the midgets are presented and compared to those made on children of approximately the same stature and on normally developed adults.

5. Male midgets appear to be closer to the 7-year-old boys group in general body size, and the female midgets are nearest the 6-year-old girls group in this respect.

6. Midgets as a group vary enormously in the degree of maturation of various parts of the body. Some head and body proportions are distinctly infantile-like while others more nearly resemble those of the normally developed adults.

7. Certain characteristics of the face and head appear to be almost universal among midgets. Among these may be noted: thin lips; fine hair texture; scanty eyebrows with little or no concurrency; bulging temporal regions; and large ear lobes.

8. Many different body types are represented among the midgets. Extreme linearity of physique, however, is rare.

LITERATURE CITED

RISCHBIETH, H. 1912 Dwarfism. Treasury of Human Inheritance. London, vol. 1.

PLATE 1

EXPLANATION OF PLATE

Upper left — "Fetal-like midget"	Age 18 years, stature 30.5 inches
Upper right — "Fetal-like midget"	Age 18 years, stature 34.2 inches
Middle left — "True midget"	Age 30 years, stature 44.2 inches
Middle right — "True midget"	Age 22 years, stature 40.5 inches
Lower left — "Miniature"	Age 20 years, stature 53.8 inches
Lower right — "Miniature"	Age 32 years, stature 48.0 inches

PLATE 1

OBSERVATIONS ON THE TEETH OF CHINESE BORN AND REARED IN CHINA AND AMERICA

(INCLUDING DATA ON PEKING PRISONERS COLLECTED BY LIANG SSU-YUNG)

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ONE FIGURE

INTRODUCTION

During a study of the physical anthropology of Chinese in America, the question has arisen whether Chinese born and brought up in North America differ in the condition of their teeth from Chinese born and brought up in China. Since the Chinese born in the United States and Hawaii and the immigrants from China were of the same racial stock, differences found between them could be ascribed to factors in the changed environment, such as new food habits.

The writer examined 281 adult male Chinese in the United States. Forty-eight of these were born in North America and five in Hawaii of Cantonese parentage. (The term "Cantonese" is used to refer not only to people from the city of Canton, but also to those from neighboring counties in south-central Kwangtung Province.) Ninety-seven Cantonese immigrants came from this same region. Nine other Cantonese were born elsewhere. Seventeen other Southeastern Chinese came from Fukien and eastern Kwangtung. Fifty Eastern Chinese were from the provinces of Chekiang, Kiangsu and Anhwei. Fifteen West and Central Chinese came from Kiangsi, Hunan, Hupeh and Szechwan. Twenty North Chinese came from Manchuria and the six northern provinces of China Proper. An additional twenty individuals are labeled "Inter-regional" because their immediate ancestors came from more than one region. Virtually all the non-Cantonese examined were college students.

The mouths of all individuals were examined with the aid of a small flashlight but without the use of a probe. The number of repaired teeth plus teeth with caries-like lesions were counted. The eruption or non-eruption of third molars was recorded. The presence and degree of shovel-shaped upper incisors, of attrition, and of crowding were recorded. The subjects were asked to bite and, with the teeth articulated,

the anterior-posterior relationship of the upper to lower incisors was noted.

In the winter of 1927–1928 Liang Ssu-yung made similar observations on 367 Chinese male prisoners in Peking. He has kindly consented to the use of this hitherto unpublished material. Though his data are not from individuals of strictly the same socio-economic status as the data collected in America, the comparison is often suggestive.

DENTAL CARIES

Chinese in China. From the literature listed in table 1 it may be seen that dental caries is relatively rare among Chinese; usually less than half the individuals are reported to be affected. (See also Merrins, '10; Lindsay, '18; and Brick, '41. Baranoff, '32, wrote that caries, once rare, is increasing rapidly.)

TABLE 1

Dental caries according to previous studies of Chinese.

AUTHOR	MATERIAL	NO. OF INDIVIDUALS	PER CENT OF INDIVIDUALS WITH CARIES	PER CENT OF TEETH WITH CARIES
Liang	Peking, prisoners	367	20.0	
Merrins, '10	students		35	
Agnew and Agnew, '31	Szechwanese		42.6	
Sakai, '26	Fushun, laborers	2,928	41.21	3.64
Sakai, '26	Fushun, students	224	35.27	3.85
Suzuki, '20	Manchurians	636	39.0	4.9
Nakayama (Enisi, '38)	Manchuria, students		52	
Kasanuki (Enisi, '38)	Manchuria, students		39	
Ryuraku (Enisi, '38)	Koreans		48.8	
Anderson, '32	Peking, mostly students	865	43.4	2.1 [1]
Anderson, '32	Taiyuan, military police	110	25.5	
Anderson, '32	Mongols from near Kalgan	25	0	0
Montelius, '33	Kwangtung, soldiers	545	42.6	
Montelius, '33	students	2,939	67.0	
Montelius, '33	total series	4,474	58.8	7.6
Maruyama, '38–'39	Formosa-Chinese	1,379	19.5	
Field, '29	Malaya-Chinese	100	49.0	
Appleton (Shirokogoroff, '25)	Kiangsu, young males	267	24.1	
Appleton (Shirokogoroff, '25)	Chekiang, young males	263	25.5	
Appleton, '25 a	Chinese, children	699	39	
Appleton, '25 b	Hawaii-Chinese, boys	388	78	
Appleton, '25 b	Hawaii-Chinese, girls	354	90	
Jones et al., '30	Hawaii-Chinese, children	182	91.2 [2]	
Ogata and Miyaka, '21	Chinese skulls	157	36.3	3.33
Koganei, '34	Chinese skulls	101	20–25	3.2
Klatsky and Klatell, '43	Chinese skulls	53		5.0

[1] Permanent teeth; 16.1% of the deciduous teeth in the same series were carious.

[2] Deciduous teeth.

Of 367 Chinese convicts studied in a Peking prison by Liang, only seventy-three (20%) showed dental caries, and over 70% had neither caries nor loss of teeth. The average age of the prisoners studied was approximately 35, but those with caries averaged 42, and those with most caries still older. No caries occurred in the twenty individuals under 22 years old, but from that age on the incidence of caries gradually increased in each 5-year period until the late forties. This finding differs markedly from Montelius' ('33) observation that caries in Chinese is at a maximum in the 15–19-year-old group, and does not vary much after that. In Montelius' very composite series the regions and classes with most caries may have been better represented among the younger individuals. Furthermore, in Liang's series mild early cases may not all have been recorded.

It should be noted in connection with the age factor that whereas in modern society dental caries is a disease of youth, among Australian and other aborigines living their accustomed lives, caries — when it occurs at all — is a disease of older age and is said to be associated with pronounced attrition of the occlusal and interproximal surfaces of the teeth (Campbell, '39). In the Peking prisoners studied by Liang there was a very high positive correlation between the degree of attrition and the presence and severity of dental caries.

In order to determine whether it is attrition itself, and consequent exposure of the dentine, which gives rise to caries in older Chinese, or whether it is only that both conditions are affected by age, an analysis may be made by age groups. In Liang's series there seems to be no association between attrition and caries independently of the age factor. In only one individual were the two conditions apparently related. This case, aged 31, was the only prisoner in the whole series reported to have had very pronounced caries, yet he was by far the youngest individual reported to have had very marked wear of the teeth. Be that as it may, it is clear that age, independently of the factor of attrition, has a very marked effect on the likelihood of caries, for of individuals with equal degrees of wear, the older ones are much more liable to caries and more liable to have larger numbers of teeth affected.

Loss of teeth occurred in ninety-two (25%) of the Peking prisoners. Usually only one tooth was missing; in only 6% of the cases were more than four missing; and in only three cases (1%) were more than half the teeth missing. On the average 1.05 teeth per individual were lost. Upper teeth were lost twice as frequently as lower teeth; most of the missing teeth being molars, while canines were the least frequently lost. The large percentage of back-teeth lost suggests that the sequelae of

caries are the chief causes of loss, especially in view of the very high correlation of carious and missing teeth in the same individuals.

Though relatively little caries is found in various regions of China, dietary deficiency is not uncommon. In some regions the diet is known to be low in vitamins A, B, C or D. Calcium is notably deficient in the diets of many Chinese in almost all parts of China (Adolph, '29; Agnew and Agnew, '31; Lu, '34; and Buck, '37). Yet it is probable that members of the Chinese race require as much calcium as Europeans (Chu et al., '41). Thus it seems clear that the low calcium intake of Chinese does not necessarily lead to prevalent decay of the teeth. The vitamin deficiencies also do not seem to be involved.

Overseas Chinese. With the exception of Formosa Chinese, the teeth of emigrants are much more liable to be afflicted with caries than are those of Chinese in their native land. As early as 1908 an anonymous author remarked that among Chinese in the mines of Johannesburg, South Africa, toothache, for some unexplained reason, was very prevalent. In each compound there were always several men suffering in this way, and each week ten or twelve patients had teeth extracted.

Appleton ('25a, '25b, '28) some of whose observations have been published by Shirokogoroff ('25), was the first to make systematic studies on the dental and other conditions in Chinese in China and abroad. Her findings with respect to caries show a much higher percentage of Chinese children in Hawaii to have dental caries than the series she examined in China (see table 1). Appleton ('28) found caries more severe as well as more frequent in Hawaiian-Chinese. Thus, whereas 49% of the Hawaiian-Chinese boys and 60% of the girls had three or more carious teeth, among the girls in Chekiang Province only 5% had three or more decayed teeth, and half of those with caries had but one tooth affected.

A more recent study on 5- to 6½-year-old children in Hawaii by Jones, Larsen and Pritchard ('30) showed very prevalent caries and rampant decay among Chinese and other Oriental groups in Honolulu and rural Hawaii. Dental decay is reported to be somewhat less prevalent in Caucasians and part-Caucasians.

As various methods have been employed in the past, the present data on caries are not strictly comparable to those of other studies. The question of whether missing teeth are to be calculated as carious or not makes a difference in one's interpretation of data on caries. In the present series there is a considerable excess of individuals whose dentitions are free from both caries and loss over what would be expected if the number of lost teeth and the number of carious teeth were com-

pletely independent. However, in general there is little correlation between the loss of teeth and the percentage of the remaining teeth found to be carious. This is chiefly because in America, where caries tends to reach a maximum, much more adequate dental care is available and teeth are less likely to be sacrificed. In China, on the other hand, the only type of dental treatment available until recently was extraction, and this was widely practiced for persistent toothaches. In the present study the one edentulous individual and the three other nearly edentulous individuals were all China-born. In estimating the degree of excess of caries in American-born over immigrant Chinese, the most conservative assumption would be that all teeth lost had been carious.

Let us consider first the data on caries in Chinese in America according to native province (see map and table 2). The differences between regions are not very great. The highest incidence of caries and lost

TABLE 2

Average number of carious and lost teeth and per cent without caries or loss among Chinese in America.

	CARIOUS TEETH, AVERAGE PER PERSON	LOST TEETH, AVERAGE PER PERSON	LOSS-FREE AND CARIES-FREE		TOTAL NUMBER
			No.	*%*	
Cantonese immigrants	2.84	1.63	25	25.8	97
Other Cantonese	4.44	1.00	0		9
American-born	6.12	1.29	4	8.3	48
Hawaiian-born	12.80	0.80	0		5
Southeast	2.53	0.47	3	17.6	17
East	3.28	1.04	15	30.0	50
West and Central	1.40	0.60	6	40.0	15
North	1.60	1.00	9	45.0	20
Interregional	2.60	0.45	6	30.0	20
Total	3.50	1.18	68	24.2	281

teeth is to be found in the urban centers of East China and in Fukien and Kwangtung, coastal provinces with much overseas commerce. The regional differences in caries and loss do not seem to be very significant. Such differences as occur may be caused by any of many factors such as diet, climate, race, or what is sometimes vaguely called "degree of Westernization."

Though differences between various parts of China are small, Chinese born abroad differ markedly from those brought up in China in respect to the frequency of caries. It is evident that the worst dental conditions are to be found among Chinese born and brought up in foreign lands — whether semitropical or temperate: United States, Hawaii and Hong


DENTAL CARIES
IN
CHINA
INNER MONGOLIA
MANCHURIA
NINGHSIA
KANSU
HOPEI
PEIPING
TIENTSIN
DAIREN
TAIYUAN
SHANSI
SHANTUNG
SHENSI
YELLOW SEA
HONAN
KIANGSU
ANHWEI
SHANGHAI
SZECHWAN
HUPEH
CHENG TU
HANKOW
SIKANG
CHUNGKING
CHEKIANG
HUNAN
KIANGSI
KWEICHOW
FUKIEN
KUNMING
KWANGSI
KWANGTUNG
FORMOSA
YUNNAN
WEST RIVER
HONG KONG
SOUTH CHINA SEA
FRENCH INDO CHINA
HAINAN
AVERAGE NO. OF CARIOUS TEETH
1.40 WEST AND CENTRAL
1.60 NORTH
2.53 SOUTHEAST
2.84 CANTON REGION
3.28 EAST

Figure 1

Kong. The difference in susceptibility to caries between American-born and Chinese-born Cantonese is so great that, even without subtracting the Hong Kong-born from the former or adding the Hawaiian-born to the latter, there is no doubt of statistical significance. Furthermore, a difference of this extent could not be accounted for by the higher infant mortality rate in China even if all the individuals most susceptible to caries were thus eliminated.

As for the age factor, Cantonese immigrants, excluding those from Hong Kong, seem to show little if any tendency towards increasing numbers of carious teeth with advancing age. Furthermore, there is little association of caries with attrition. Loss of teeth, however, as in the case of Liang's series, progresses with age: from an average of 0.70 teeth in individuals under 25 years old to 1.55 in the 25- to 32-year-old period, and 4.06 in still older individuals.

TABLE 3

Caries and loss of teeth among Cantonese immigrants (excluding those born in Hong Kong) by age at migration.

AGE AT MIGRATION	CARIOUS TEETH, AVERAGE PER PERSON	LOST TEETH, AVERAGE PER PERSON	LOSS-FREE AND CARIES-FREE		TOTAL NUMBER
			No.	%	
Under 5	6.00	0.60	1	20.0	5
5–13	2.43	0.62	8	38.1	21
14–19	2.13	2.27	7	23.3	30
20–up	1.47	1.97	11	34.4	32

If one classifies the Cantonese immigrants by their ages at the time they migrated to America, one gets a very different picture (table 3). Caries, it may be seen, tends to be most marked in those who came to the United States while still young. As some of these individuals were among the youngest examined, it offers a partial explanation for the lack of a marked age factor. There is a strong tendency for those who have been in the United States longest to show the most caries. Loss of teeth, however, is less common among Chinese who immigrated while still children.

Considering those Chinese born in America (table 4), seventeen had been to China where they had spent an average of 6.9 years apiece, more than a quarter of their lives. It is precisely this sub-group which tends to show least caries among the American-born: less than those who had been exposed to American conditions all their lives.

The Chinese born in America may be examined in more detail with respect to the part of the country in which they had been raised. Those

from Hawaii show the most caries, those from Eastern United States, the least, and those from the West Coast are intermediate. The Hawaiian and West Coast Chinese in this series were almost all students and were more accustomed to American culture and less conversant with Chinese manners than those born in the East (and this despite the fact that in Hawaii and on the West Coast the Chinese live in larger aggregations and are closer to their homeland). These differences in degree of acculturation are apparently related to the incidence of dental caries.

TABLE 4

Caries and loss of teeth among American-born Chinese by place of birth.

BIRTHPLACE	CARIOUS TEETH, AVERAGE PER PERSON	LOST TEETH, AVERAGE PER PERSON	LOSS-FREE AND CARIES-FREE		TOTAL NUMBER
			No.	*%*	
Hawaii [1]	12.80	0.80	0	0	5
West Coast [1]	9.70	1.00	0	0	10
Eastern U. S.[1]	6.19	1.48	2	9.5	21
Eastern U. S.[2]	3.94	1.24	2	11.8	17

[1] Never been to China.

[2] Lived in China for a period.

TABLE 5

Caries and loss of teeth among Chinese by city of birth.

CITY OF BIRTH	CARIOUS TEETH, AVERAGE PER PERSON	LOST TEETH, AVERAGE PER PERSON	LOSS-FREE AND CARIES-FREE		TOTAL NUMBER
			No.	*%*	
Hong Kong	7.25	1.83	1	8.3	12
Shanghai	4.31	0.46	5	19.2	26
Canton	3.46 [1]	0.92	2	15.4	13
Peking	1.22 [1]	0.50	9	50.0	18

[1] In Canton and Peking the individual with the most numerous carious teeth had, in each case, lived for some time in Hong Kong.

If the immigrants measured in the United States are arranged according to cities of their birth, regardless of the provincial and racial origins of their antecedents, it will be seen that there are considerable differences in the frequency of caries (table 5). In Hong Kong there is significantly more caries than in other cities, and of Canton- and Peking-born Chinese examined in America, the individuals with the most carious teeth had in each case lived for some time in Hong Kong. It is notable that there is much less dental caries in the more typically Chinese city of Canton than in Hong Kong only a few miles away. Though Canton is the largest city of the province, its inhabitants have only slightly

more carious teeth and fewer lost teeth than people from the nearby agricultural villages. In Shanghai there is slightly more caries and less loss of teeth than in the remainder of the Eastern region. The inhabitants of the cities of East China show more dental decay than those of the much less industrialized city of Peking, and — to judge from the data collected by Liang and Anderson — than in other towns and cities of North China.

Urban life itself does not necessarily lead to dental decay. Although in China, as in other parts of the world, there is generally more caries in cities than in the surrounding countryside, nevertheless it is seen that this does not hold for all large Chinese cities. In Liang's study in Peking, eighty-nine prisoners born in the city showed no appreciably greater tendency to caries and loss of teeth than prisoners from other districts of Hopei Province. Only those urban communities which have an extensive modern industry coupled with foreign commerce appear to show higher rates of dental decay.

The factor which most obviously fits the findings of distribution of caries is dietary. The diet of Cantonese in America may be compared with that of Chungshan, one of the very counties from which they came. Buck's ('37) study indicates that the poverty in Chungshan leads to the eating of little other than polished rice. The diet is lower in calcium and vitamins than is the case with Chinese in America (Hawks, '31; Wang and Hawks, '32; Krakower, '34). The most notable additions in Hawaii and America to the Chinese diet are an increased use of milk and animal protein foods, and of coffee, desserts and sweets (Appleton, '28).

Conclusions on dental caries. Chinese born and brought up in Hawaii and mainland United States have a much higher incidence of dental caries than Chinese born and brought up in China. Of the latter it is particularly those from the most modernized communities who show most caries. This suggests that there is an important etiological factor in caries which is environmental rather than racial. That this factor is not limited to the pre-natal or infant periods but has a continuing deleterious effect on the teeth is indicated by three facts: first, immigrants have less caries than American-born but seem to have more caries than Chinese examined in China; secondly, the occurrence of caries in immigrants varies inversely with the age at time of migration; and thirdly, American-born Chinese who have lived part of their lives in China have less caries than those who have never been to China.

The most plausible interpretation of the differences in caries incidence is that some food added to the diet, such as sugar, is largely responsible

for the increased dental decay. In any case, dietary deficiency seems not to be involved. Many Chinese with poor teeth ascribe this condition to the eating of "too much candy". Such an explanation, suggested by the study of emigrants, is also supported by the finding of much dental caries in the port cities of China and in the sons of wealthy merchants and officials.

CROWDED AND IRREGULAR TEETH

The first students of the dental pathology of Chinese remarked that the teeth were as a rule remarkably free from crowding. Kingsley (1879) quotes a Dr. Nichols as saying that, among thousands of Chinese and Indians examined in the Rocky Mountains and on the Pacific Coast, he found but one case of irregularity of the teeth, a Chinese woman with a displaced canine. Talbot (1890) wrote that of 300 Chinese examined in 1881 none showed irregularity in the shape of jaws or teeth. In 1902 Haberer mentioned only one of thirty-seven skulls from Peking as having teeth pushed out of line.

Recent investigations give evidence that crowded teeth are now of frequent occurrence among Chinese (Bennett, '14; Keith, '24; Brash, '29; Koganei, '34a). Ogata and Miyaka ('21) found 16 (10.2%) of 157 Chinese skulls with deviation of lower third molars, though they found nothing unusual in the upper jaws. Harrower ('28), in his study of the mandible, found that without exception the molar teeth are well spaced but that in 51 out of 77 Hainan and Fukien mandibles there was a distinct tendency to crowding of the incisor and canine teeth, apparently caused by the narrowing of the arch into a parabolic form. Oshima ('37b) found, in the skulls of 1,250 male Chinese, 24.2% with rotated maxillary teeth and 12.6% with rotated lower teeth. In another study ('37a) he found 30 out of 366 skulls with anomalous position of one or more third molars. Sakai ('28) examined 2,928 Manchurian Chinese and found 6.93% with crooked teeth. Montelius ('33) examined the teeth of 4,474 Chinese from various parts of China and found 1,473 (32.9%) with various degrees of irregularity of the teeth, the incidence being 22.6% in Cantonese soldiers and 30.0% in students. Similarly Appleton found 27 (12%) of 224 Chekiang girls to have strikingly irregular teeth.

In his study of prisoners in Peking, Liang recorded the incidence of irregularity: of 358 individuals 18 (5.0%) had very irregular teeth and 29 (8.1%) others had irregular teeth.

In the present study observations of malposition and rotation of the teeth caused by inadequate room in the dental arches were recorded (table 6). There are apparently no significant regional differences in

the degree of such crowding, though there may be some tendency for North Chinese and for Cantonese immigrants to show slightly less tendency in that direction. Medium and pronounced crowding of the teeth, however, are significantly more frequent in American-born Chinese than in immigrants, but this tendency would be less apparent if the Hawaiian-born individuals were included with those born in mainland United States. (Shapiro, '31 and '39, found a negligible tendency for Hawaiian-born Chinese to have more frequently rotated median incisors, and no such tendency in Hawaiian-born Japanese).

TABLE 6

Crowding of the teeth among Chinese.

	ABSENT		VERY SUBMEDIUM		SUB-MEDIUM		MEDIUM		PRO-NOUNCED		TOTAL
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*
Cantonese immigrants	50	53.8	6	6.4	17	18.3	16	17.2	4	4.3	93
Other Cantonese	4	44.4	1	11.1	2	22.2	1	11.1	1	11.1	9
American-born	19	39.6			10	20.8	15	31.2	4	8.3	48
Hawaiian-born	5	100.0									5
Southeast	8	47.1			1	5.9	3	17.6	5	29.4	17
East	18	37.5	1	2.1	10	20.8	12	25.0	7	14.6	48
West and Central	6	40.0			4	26.7	3	20.0	2	13.3	15
North	9	45.0	1	5.0	5	25.0	3	15.0	2	10.0	20
Interregional	8	40.0			5	25.0	5	25 0	2	10.0	20
Total	127	46.2	9	3.3	54	19.6	58	21.1	27	9.8	275

In the present series of Cantonese immigrants, if the students are compared with workmen, it is seen that the latter show significantly less crowding of the teeth. Only 10% of 41 laundry and restaurant workers had medium or marked crowding as compared with 39% of 36 students and college graduates. The students from Kwangtung, futhermore, are closely comparable to the students from other regions and to the student sons born in America of working-class Cantonese families.

"Racial purists" aver that crowding of the teeth is the result of disharmony of tooth size and jaw size caused by outbreeding. In the present "Interregional" series, whose immediate ancestors came from more than one region, there is little tendency towards more marked crowding. The group showing the least crowding, however, is composed of Cantonese workingmen whose parents must, in most cases, have come from adjacent villages.

Some previous investigators have sought to associate irregularity of the teeth with caries and to ascribe both to the same causes (Collins, '32; Price, '39). Montelius ('33) reported some correlation of the two condi-

tions in Chinese. Neither Liang's data nor the present writer's, however, show a correlation of irregularity or crowding of the teeth with caries except in very marked degrees of these conditions. On the contrary, among Chinese born in Hawaii and Hong Kong, where caries is most prevalent, crowding of the teeth is extremely rare.

One factor which might suggest itself as a possible cause of crowded teeth is lack of sunlight: crowded teeth may be an aftermath of subclinical rickets. Such a hypothesis might explain the higher incidence in persons brought up in the crowded Chinatowns of mainland United States than in persons born in Hawaii and Kwangtung, in students than in non-students, in the port cities of East China than in other parts of the country. One difficulty with the hypothesis is that whereas crowded teeth are not uncommon in Chinese in modern times, rickets is said to be very rare — at least in communities where glass is not yet used for the windows (Hartman, '27; Wung, '31). Appleton ('28), however, indicated that it may be only the classical gross symptoms of rickets that are rare, and that with the use of x-rays many additional cases have been revealed.

FORM OF THE DENTAL OCCLUSION

In addition to the present data there are several references in the literature to the nature of the bite in Chinese, and though many of the studies have been made on skeletal remains, they are included here for comparison.

The tendency for the majority of Chinese to show a definite overbite has been remarked by all investigators (table 7; the reports of Bennett, '14 and Nakajima, '18, include similar evidence). It is more notable in the data of Liang than in any previous study. Some authors have used a special terminology: "hyatodontia" for an open bite; "opisthodontia" for pronounced overbite; "stegodontia" for pronounced overbite with prodontism; "psalidodontia" for submedium overbite; "labidontia" for a meeting of the incisors edge to edge; and "progenia" for underbite. These studies show that "psalidodontia" is the prevalent category (table 8).

Without quoting comparative figures in detail, it appears from the works of most authors (Miyamoto, '24; Yamada, '31; Koganei, '34a; and Koya, '37) that Japanese show fewer of the edge-to-edge type and more of the overbites than Chinese. This would tend to confirm the correctness of the popular view that Japanese are especially prone to show a conspicuous protrusion of the upper front teeth. Hirose and his coworkers ('25), however, found occlusion in Japanese very similar to that

reported for Chinese. In any case, other Mongoloid and other Far Eastern peoples, such as Giliak, Orotshonan, Aino, Eskimo, Malay and Tibetan, all show more frequent edge-to-edge bites than either Chinese or Japanese. Thus the less civilized peoples of Mongoloid race share a tendency to edge-to-edge bite with other so-called primitive peoples.

In the analysis of the present data according to regional origin of the subjects, there are no very apparent differences except that those of Cantonese descent, whether born in Kwangtung, Hong Kong, Hawaii,

TABLE 7

Types of bite in Chinese.

	PRONOUNCED OVERBITE		SUBMEDIUM OVERBITE		EDGE-TO-EDGE BITE		UNDERBITE		TOTAL
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*
Cantonese immigrants	16	17.0	64	68.1	12	12.8	2	2.1	94
Other Cantonese	1	11.1	7	77.8	1	11.1			9
American-born	6	12.8	30	63.8	9	19.2	2	4.3	47
Hawaiian-born	1	20.0	4	80.0					5
Southeast	4	23.5	11	64.7	2	11.8			17
East	14	28.0	31	62.0	5	10.0			50
West and Central	4	26.7	10	66.7			1	6.7	15
North	6	30.0	12	60.0	2	10.0			20
Interregional	5	25.0	14	70.0	1	5.0			20
Total	57	20.6	183	66.1	32	11.6	5	1.8	277
North (Liang)	126	36.5	155	44.9	58	16.8	6	1.7	345
Hainan skulls (Harrower, '28)			33 [1]	84.6 [1]	6	15.4			39
Various provinces (Montelius, '33)			3,991 [1]	89.0 [1]	257	6.0	20	0.5	4,466

[1] Includes all degrees of overbite.

TABLE 8

Percentage frequency of types of bite in Chinese.

	HIATODONTIA	OPISTHODONTIA	STEGODONTIA	PSALIDODONTIA	LABIDONTIA	PROGENIA	NO. TOTAL
Fukien-Chinese in Formosa (Maruyama, '33)	0.7	3.0	11.5	68.1	14.2	2.5	2,056
Male Manchurian miners (Hada, '36)	0	0	5.7	88.9	4.1	0	1,000
Female Manchurian prostitutes (Hada, '38)	0	0	0.7	86.6	12.7	0	300
Skulls (Ogata and Miyaka, '21)	1.5	0	22.2	61.5	14.8	0	135
Skulls (Koganei, '34 a)	0	7.5	0	82.5	10.0	0	40
Peking skulls (Haberer, '02)	0	6.0	23.0	59.0	12.0	0	17
Chinese and Japanese skulls (Welcker, '02)	0	5.5	33.3	50.0	11.1	0	18

North America or elsewhere, seem to show less frequent pronounced overbites than do individuals from any other region of China. This is not because of the different class composition of the Cantonese series, since there is no difference in respect to bite between immigrant Cantonese students and workingmen. Compared with the immigrants from Kwangtung there is a slightly greater incidence among the American-born of edge-to-edge and underbites, and a smaller incidence of pronounced overbites. In his data on male Japanese immigrants to Hawaii, Shapiro ('39) shows a similar trend. However, the importance of such slight tendencies is very doubtful. Several of the American-born Chinese had had orthodontic treatment, and this might tend to decrease the frequency of abnormal types of occlusion in this group.

As the foreign-born offspring of emigrant Chinese and Japanese show practically no tendency to become differentiated in respect to the form of the bite, it is probable that the bite is a relatively stable racial attribute. The fact that among Mongoloid peoples there is a clear difference, in respect to the bite, between those who have a highly civilized way of life and others with more simple existence suggests that over many generations there may be changes in the form of the bite — from edge-to-edge bite to various degrees of overbite — associated with changing ways of life. The prevalence of edge-to-edge bite has been observed, of course, in the less advanced populations generally and points to a common cause. Selection of a genetic type — possibly with increasing adoption of a cereal diet — rather than plasticity in the individual, is probably the explanation for differences in the bite.

ATTRITION OF THE TEETH

For the most part differences in wear of the teeth merely reflect age differences. As may be seen from table 9, attrition is very closely correlated with age. Liang's and the present author's data show that attrition is a gradual and progressive process.

Even when allowance is made for age, some differences between the degree of wear of the teeth are still evident. Thus attrition is more advanced in North Chinese, particularly during young adulthood (table 10). In general there is considerably less wear of the teeth in foreign-born Cantonese than in emigrants of comparable age. These differences may be partly caused by differences in the amount of grit in the habitual foods of the various areas.

ERUPTION OF THIRD MOLAR TEETH

A reduction of the number of molar teeth through the failure of the wisdom teeth to erupt has often been described as a progressive evolu-

tionary trend almost unique to man. It has been observed, however, that this trend is not evenly distributed among the various races.

The failure of the third molar teeth to erupt has been reported as a relatively frequent occurrence in Chinese (table 11). It seems quite likely that a considerable percentage of the unerupted teeth recorded

TABLE 9

Wear of teeth among Chinese by age group.

AUTHOR	AGE	ABSENT		SUBMEDIUM		MEDIUM		PRONOUNCED		VERY PRONOUNCED		TOTAL
		No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*
Lasker	Under 18	7	77.8	2	22.2							9
	18–20	30	78.9	7	18.4	1	2.6					38
	21–25	70	73.7	20	21.1	3	3.2	2	2.1			95
	26–30	35	42.2	36	43.4	12	14.5					83
	31–35	2	6.5	15	48.4	9	29.0	5	16.1			31
	36–up			5	23.8	11	52.4	5	23.8			21
Liang	16–20			9	90.0	1	10.0					10
	21–25			34	69.4	13	26.5	2	4.1			49
	26–30			45	58.4	28	36.4	4	5.2			77
	31–35			32	45.1	24	33.8	14	19.7	1	1.4	71
	36–40			8	15.7	21	41.2	21	41.2	1	2.0	51
	41–45			5	12.5	20	50.0	15	37.5			40
	46–up			1	1.4	19	27.9	42	61.8	6	8.8	68

TABLE 10

Attrition of teeth among Chinese in America.

	ABSENT		SUBMEDIUM		MEDIUM		PRONOUNCED		TOTAL
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*
Cantonese immigrants	41	44.1	32	34.4	13	14.0	7	7.5	93
Other Cantonese	7	77.8	2	22.2					9
American-born	34	75.6	8	17.8	2	4.4	1	2.2	45
Hawaiian-born	5	100.0							5
Southeast	7	43.8	7	43.8	2	12.5			16
East	25	52.1	16	33.3	5	10.4	2	4.2	48
West and Central	5	33.3	7	46.7	3	20.0			15
North	3	15.0	7	35.0	8	40.0	2	10.0	20
Interregional	13	65.0	4	20.0	3	15.0			20
Total	140	51.7	83	30.6	36	13.3	12	4.4	271

are really impacted, for Montelius ('32) found three times as many impactions in Chinese as in Caucasians; 34.2% of 1,058 male Chinese for whom complete oral roentgenograms were available showed impactions. In a small series of Chinese, however, Hellman ('28) reported that, though non-eruption was common, only 4% of the mandibular third molars were impacted.

Unerupted teeth were very frequent in Liang's series. He observed 367 adult males of whom 142 (38.7%) had 372 (25.3%) unerupted third molars. The percentages of individuals with fully erupted teeth when plotted by age groups show that the final percentage is reached at about 28 years of age (table 12). This is similar to Mori's ('31) finding on Japanese. The formulae for the unerupted third molar teeth in Liang's series with their frequency of occurrence in individuals are given in table 13.

TABLE 11

Percentage of Chinese 28 years old and over with all third molars completely erupted.

	TOTAL NO.	COMPLETELY ERUPTED	
		No.	%
Cantonese immigrants	39	29	73.6
Other Cantonese	2	1	50.0
American-born	4	2	50.0
Hawaiian-born	1	0	0
Southeast	9	6	66.7
East	15	11	73.3
West and Central	11	8	72.7
North	14	9	64.3
Interregional	3	2	66.7
Total	98	68	69.4
North (Liang)	276	182	65.9
Fushun (Sakai, '26)	3,152	2,022	64.15
Skulls (Ogata and Miyaka, '21)			67.4
Chinese in Java (Knap)	64	44	68.8
Skulls (Koganei, '34 a)	96	77	80.0
Skulls (Oshima, '37 a)	366	171	46.7
Hainan and Fukien mandibles (Harrower, '28)	57	39	68.4

TABLE 12

Percentage of Chinese with third molars all completely erupted, by age groups.

AGE	LASKER			LIANG		
	Total	Completely erupted		Total	Completely erupted	
	No.	*No.*	%	*No.*	*No.*	%
16–20	47	14	29.8	10	3	30.0
21–25	97	49	49.5	49	23	46.9
26–30	87	47	54.0	76	50	65.8
31–35	37	24	64.9	70	43	61.4
36–40	14	10	71.4	51	30	58.8
41–45				40	29	72.5
46–50				39	29	74.4
51–55				21	12	57.1

The present study of Chinese examined in America indicates no appreciable differences in third molar eruption between different regions, at least not if the age factor is taken into account. There may be some tendency towards continuing eruption after the age of 28, but this is not statistically significant.

TABLE 13

Patterns of third molar suppression among Chinese (Liang).

Maxillary	RL			L		RL	L	RL	R	R	R	L	RL	L	None	Total
Mandibular	RL	RL	L		R		L	R	RL		R	R	L	RL		
No. of individuals	60	18	16	11	8	6	5	5	3	3	2	2	2	1	225	367

In Chinese from all parts of China the lack of the third molars, whether congenitally absent or incompletely erupted because of impaction, is very frequent. This occurs not only in all series of Chinese but also in Japanese, Eskimos and other Mongoloid groups. A high incidence of failure of the third molar teeth to erupt seems to be characteristic of the Mongoloid race (Goldstein, '32).

SHOVEL-SHAPED INCISORS

Hrdlička ('20) first called attention to the interesting racial distribution of shovel-shaped incisors. He reported that of 547 young Chinese males, the upper incisors of 94% showed some trace of the enamel rims which form the shovel-shaped fossae on the lingual surfaces, and a deep fossa was observed in the teeth of over half the individuals. In 104 young women this characteristic form of the incisors occurred even more frequently.

Among 367 male prisoners in Peking Liang recorded 114 (33.5%) to lack the trait, 41 (12.1%) to have two of the upper incisors shovel-shaped, 177 (52.1%) to have four of the upper incisors shovel-shaped, one (0.3%) to show the trait in four upper and two lower incisors, and seven (2.1%) to have all eight incisors shovel-shaped. Though it is not possible to judge exactly what standards were applied by Liang, it seems probable that he recorded only well marked cases. At any rate, his data concur with Hrdlička's in that all four upper incisors were usually found to be affected and that lower incisors also sometimes showed the condition.

Montelius ('33) found a shovel-shaped fossa in one or more upper incisors in 3,520 individuals out of a total series of 4,466 Chinese. As some of the remaining individuals may once have had the trait but sub-

sequently lost or severely worn the affected teeth, the real incidence was probably somewhat higher than 79% for this series.

Stevenson's ('40) results are very similar to those of Montelius. In a series of 904 males from the North China Plain the folds were absent from the upper median incisors of 165 (18.2%) of the individuals. The shovel-shaped median incisors were slightly marked in 178 (19.7%), medium in 487 (53.9%) and marked in 74 (8.3%). The upper lateral incisors showed the shovel-shaped form more often (85.9%) and in these teeth it was more frequently of medium or marked degree.

Morse ('37) has published a valuable preliminary schedule of observations. Without wishing to anticipate the fuller exposition of this data, it may be remarked that in his Chinese series pronounced shovel-

TABLE 14

Shovel-shaped incisors among Chinese in America.

	ABSENT		SUBMEDIUM		MEDIUM		PRONOUNCED		TOTAL
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*
Cantonese immigrants	1	1.1	10	11.0	67	73.6	13	14.3	91
Other Cantonese	1	12.5	1	12.5	5	62.5	1	12.5	8
American-born	1	2.2	5	10.9	31	67.4	9	19.6	46
Hawaiian-born			1	20.0	4	80.0			5
Southeast	1	5.9	3	17.6	10	58.8	3	17.6	17
East			7	14.6	32	66.7	9	18.8	48
West and Central			2	13.3	11	73.3	2	13.3	15
North	1	5.0	4	20.0	8	40.0	7	35.0	20
Interregional	1	5.3	2	10.5	10	52.6	6	31.6	19
Total	6	2.2	35	13.0	178	66.2	50	18.6	269

shaped incisors were more frequent in females than males, and that of people from various parts of China the highest frequencies were found in East, North and Central Chinese while Western and especially Southern Chinese showed the lowest percentages.

In the present study all but six of the 269 individuals in whom the upper incisors were present showed some form of the trait in these teeth (table 14). The most conspicuous regional difference is the tendency towards more frequent pronounced shovel-shaped incisors in Northern Chinese. Moreover, four out of ten other individuals, only some of whose immediate ancestors were Northerners, also showed the trait in very marked degree. This geographical distribution, rather than class differences, would seem to explain why Hrdlička found that: "Students from Tsing hua College, who came from all parts of China and from better families, showed a somewhat less proportion of shovel-shaped

teeth than the young men at the Young Men's Christian Association, who are also mainly Pekingese.'' As the incidence of the trait is high in Mongols, while Morse's data show it to be rarer in non-Chinese peoples of South and West China, it is not surprising to find the trait more pronounced in Northern Chinese.

In respect to shovel-shaped incisors there is virtually no difference between the frequency in American-born and immigrant Chinese who have come to the United States after their teeth have been formed. Among Chinese in Hawaii Shapiro ('31) found no consistent trend. He stated: ''The percentage of absent incisor folds is greater among males born in China than among Hawaiian-born. The reverse is true for females.'' The contrary record in Shapiro's published table 15 has been caused by transposition of the column headings through a typographical error.

CONCLUSIONS

The whole range of degrees of plasticity of individuals to the environmental changes incident to migration are best exemplified in the teeth. The various dental traits show reactions of totally different kind and extent. Thus, susceptibility to dental caries is so strongly influenced by an environmental factor that one cannot discern racial trends. Crowding of the teeth is also dominantly influenced by a similar but distinct environmental factor. On the other hand, the frequent failure of the third molars to erupt is a characteristic Mongoloid racial trait. The shovel-shaped form of the incisors is a genetic trait which shows differences even between the sub-regions of China. The form of the occlusion is apparently influenced by differences in environment acting through selection over many generations, for it distinguishes the more backward from the civilized Mongoloid peoples; the type of bite may also be slightly affected by direct influences of environment.

Those traits which vary by showing greater or lesser excellence are usually the very traits most markedly influenced by environmental factors. In these cases the laboratory provided by migration has not, however, supplied sufficiently rigorous conditions to achieve more than hypothetical solutions (the addition of such things as sugar to the diet as a cause of caries, and the lack of adequate sunlight as a factor in crowding of the teeth). The suggestive evidence points the way for more penetrating investigations. Furthermore, with the large scale migrations and readjustments in the way of life that are taking place in such countries as China, a knowledge of some of the probable physical effects will be of real value.

Other dental traits show little change even under radically altered environmental circumstances. Such characteristics may be safely utilized in the genetic study of man, and when they are free from adaptive significance — as seems true in the case of shovel-shaped incisors for instance — they serve well in the study of man's evolution.

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THE PALEOLITHIC CHILD FROM THE TESHIK-TASH CAVE IN SOUTHERN UZBEKISTAN (CENTRAL ASIA)

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TWO TEXT FIGURES AND ONE PLATE

Five years ago ('39) Dr. Aleš Hrdlička made a brief report in *Science* on the discovery of early human remains found by A. P. Okladnikoff during the summer of 1938 in the Teshnik-Tash Cave near Baisun in Southern Uzbekistan. In the following year ('40a) Okladnikoff published a more detailed account of the geological, archaeological and faunistic data of this discovery in the July and August issues of *Asia*. Okladnikoff's article is illustrated, showing the recovered skull in frontal and left lateral views together with the reconstructed bust of the individual. During the same year ('40b) the Uzbekistan Section of the Academy of Sciences of S.S.S.R. devoted an entire fascicle to the Uzbekistan Skull. In the first article of the fascicle A. P. Okladnikoff gives the geographical, geological and archaeological data of the discovery. The second article, written by G. F. Debetz deals with the anthropological peculiarities of the skeleton, and in the third article Vera Gromova describes the fauna.

According to Hrdlička's report in *Science* the human remains consisted of the skeleton of a child which was regularly buried in a cave; yet only the skull and the lower jaw were in a reconstructable condition, the other bones were gone. The skull was identified by the discoverers as a "Neanderthal child," the implements found as of a "characteristic Mousterian" type, and the fauna as an "old fauna." Hrdlička, who had the opportunity to examine the remains in 1939 adopted Okladnikoff's diagnosis without any reservation. He writes:

"The skull, with its lower jaw and all the teeth, is the most complete and in general the best Neanderthal cranium yet recovered. It belongs to a normally developed child 8 to 9 years of age. The vault is as well developed as that in the La Quina and Gibraltar children, the supraorbital region, face, lower jaw and teeth all denote unequivocably a Neanderthal specimen. The implements found with the body are typically Mousterian . . . " etc.

Although the aforementioned publications of the Russian Academy of Sciences came into Hrdlička's possession and an excellent cast of the skull and jaw was presented to the U. S. Natural Museum in Washington, D. C., Hrdlička never returned to this object nor did he publish a review in the Journal. My attention was directed to the skull when I saw photographs of it and the reconstruction of the physiognomy in Okladnikoff's article in *Asia*. Even if one is not particularly familiar with reconstructions of this kind, one will recognize at first glance that the profile of the upper face (forehead and nasal bridge), where the outlines of skeleton and skin run almost parallel, has been drawn in the reconstructed bust in a way that makes it appear much more "primitive" than is justified by the profile of the skull. Although one can expect to find Neanderthal types in this part of Asia where the skull originated, there were certain points which aroused my doubt. So I wrote to Dr. T. D. Stewart and asked him to make the cast and the Russian literature accessible to me in order to check whether the claim of the Neanderthal character of the skull could be maintained. I am very grateful to Dr. Stewart for his compliance with my request.

Two facts made me sceptical about the correct classification of the find. First, it is very difficult to determine the exact phylogenetic status of a given hominid form if it is represented only by the skull of a child. And secondly, after the discovery of the Mount Carmel population in Palestine we have to reckon with the possibility that types intermediate between the classic Neanderthalian and modern man may come to light one day from West or Central Asia. This possibility had been taken into account neither by Okladnikoff nor Hrdlička.

The morphological characteristics of the skull, on which G. F. Debetz based his diagnosis as a Neanderthal child are the following: (1) massive skull; (2) low brain-case; (3) considerably sloping forehead; (4) occiput prominent and flattened in vertical direction; (5) superciliary ridges in form of supraorbital tori; (6) flattened maxilla without canine fossae; (7) absence of the chin; (8) large teeth. According to A. P. Okladnikoff the geological and cultural evidences of the Neanderthal age of the find are furnished by the following data: The excavation in the interior of the cave exposed five strata with cultural deposits separated by sterile layers. The bones of animals — wild goat (capra sibirica), wild horse, leopard and boar — were spread over all the deposits. As the bones of the goat were predominant, it seems that the inhabitants of the caves lived chiefly from hunting this animal. In the same places there were found pieces of stone, nuclei, stone implements made of flint, more rarely of green jasper, quartzite and common quartz. The implements consisted

of chopping tools and scraping tools. Tools similar to those in the first group are frequent in settlements of the Mousterian period. The scraping tools are of the ordinary heavy Mousterian type. Some of the broadest and heaviest flakes recall closely the Levallois flakes. Most of the implements were found in association with fire places, patches of ashes and coal. The total thickness of the cave deposits was 4 to 5 feet. The human remains were discovered beneath the first cultural layer, which supplied all the reported archaeological data. The human remains consisted of the skull, fragments of long bones, ribs and vertebrae. The fact that the place where the bones were found was surrounded by horns of goat bucks in pairs is considered as an indication of a certain rite, that is to say, of burial.

The fauna of the Teshik-Tash Cave, according to Vera Gromova is represented almost entirely of capra sibirica; out of 660 individual bones found in the cave 644 or 97.2% belong to this goat. The wild boar and horse (equus caballus) are represented only by 2 bones each, the leopard and pike each by 1 bone; and the marmot by 7. All these animals are living today in Central Asia. The character of the horse as a wild one is inferred from the consideration that domesticated horses were not in use during the Mousterian period.

I do not intend to repeat here the description of the skull in all details as that has been done in Debetz' original article. Debetz made a thorough and scholarly study and elucidated it by 12 drawings and diagrams and 12 tables in which the main measurements are given.

Plate 1 shows the skull in four views. The photographs have been taken from the original by N. S. Sinelnikov and had been given to Dr. Aleš Hrdlička. Two of the views — the lateral and frontal ones — have been depicted in Okladnikoff's article in *Asia* ('40a). In addition, figure 1 gives the mid-sagittal craniogram I have taken from the cast compared with the craniogram of the Mousterian youth, the latter taken from H. Weinert's reconstruction ('25).

I want to call attention only to certain facts which I regard as pertinent and worthwhile to be reexamined and, if possible, on a much broader basis, particularly so far as the comparative material is concerned. As I have indicated above, I am not convinced that the Uzbekistan skull is an immature Neanderthal skull belonging to the European variation and is, therefore, of the same type as the skulls of La Chapelle-aux-Saints, Gibraltar and La Quina to which Debetz especially refers. The greatest difficulty each investigator has to deal with in such a case is the dearth of suitable comparative material. As to the Neanderthalians the braincases of only two children are known: the Gibraltar child and the La

Quina child. The former is incomplete and much younger than the Uzbekistan child; in the Gibraltar child all the teeth in use are of the milk set, while in the Uzbekistan child the upper and lower permanent incisors are already in place and the permanent canines are on the point of eruption. In the La Quina child the milk incisors have fallen out,

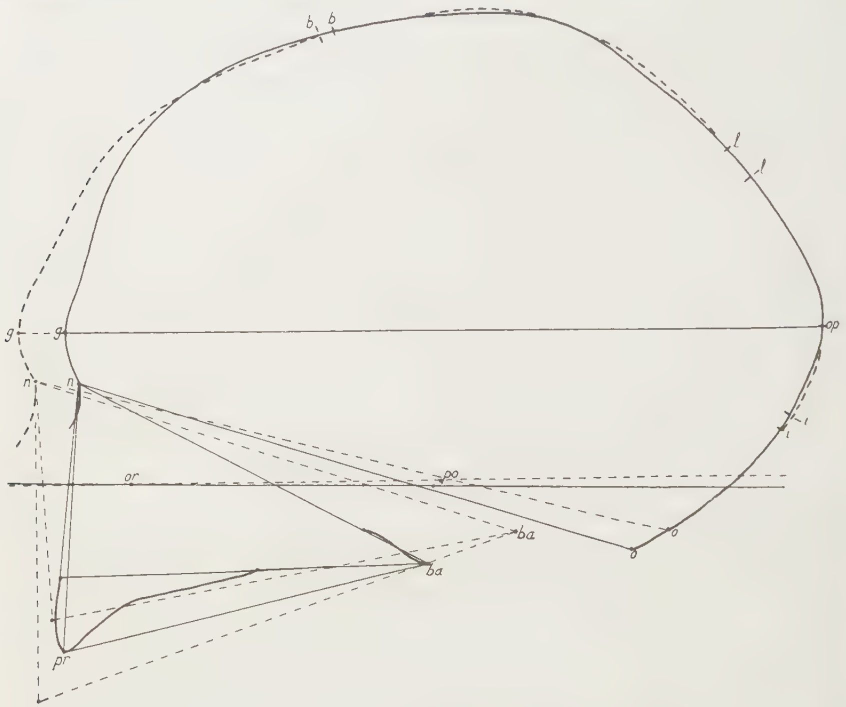

Fig. 1 Mid-sagittal craniograms of the skull of the Uzbekistan Child (——) taken from the cast, and the Mousterian Youth (— — —), copied from H. Weinert's reconstruction ('28). Both diagrams superimposed on the glabella-opisthocranion (g-op) line and on the opisthocranion. × ⅔.

These craniograms show that the frontal region projects more in the Mousterian Youth and that his face is higher and deeper. But they show at the same time that the Uzbekistan skull, in spite of its being of a younger age is much higher, basion (ba) and opisthion (o) reaching much farther downward than in the Mousterian Youth. The two Frankfort horizontals (or-po) run almost parallel and in the same distance of the glabella-opisthocranion line.

and the medial permanent incisors have just cut the gum. On the other hand, the Mousterian youth is much older. All the permanent teeth are in place and the third upper and lower molars erupting.

These differences in age are pertinent. The younger the individual the higher the skull in proportion to its length. But as the relation between

height and length is one of the criteria which serve as a gauge for the determination of the phylogenetic status of a given specimen, a high index in young Neanderthalians comes closer to modern man than in adults. Only if the index is distinctly lower than that of a modern man of the same age and sex, may it be rightly assumed that the skull is a Neanderthalian.

What strikes us first is the extraordinary size of the Uzbekistan braincase when its age (8–9 years) is taken into account. The greatest length is 185 mm. and the greatest breadth 144 mm. The cranial capacity calculated by Debetz is 1490 cc.; my estimate came to about the same figure. The skull capacity of the adult individual would, therefore, have totaled about 1600 cc. The length-total height index is 71.4 and the length-auricular height index is 61.2. In the somewhat younger La Quina child the corresponding indices are 70.2 and 61.5, in the older Mousterian youth the indices are 65.6 and 56.6. These figures (La Quina and Mousterian) show that in Neanderthal skulls the length-height index decreases with age, obviously because the increase in length is greater than the increase in height. But the figures do not prove that a low index as that exhibited by the Uzbekistan Skull is in any case specific of a Neanderthalian. As skulls of the same age as the Uzbekistan Skull are very rare in collections, and there are none in the collection of the American Museum of Natural History, I looked over the skull catalogues published in the years from 1897 to 1904 in the Archiv für Anthropologie. Among the skulls listed therein I found eleven skulls of about the same age or a little older (up to 11 years of age); nine of them are registered as European children and two as Buriats. Of the European children three have a lower length-total height index (67.9, 68.8, and 70.3) than the Uzbekistan Skull and two have also a lower length-auricular height index (57.2 and 59.6). Among the Buriat children one has a lower length-total height index (70.9); the length-auricular height is not recorded in the lists. Of the European children six have higher indices; one of them going as high as 76.7 and 70.0, respectively; the index of one of the Buriat children is even 77.7.

These figures prove that there is a great variability even among skulls of the same race today. But one point seems to me to be of great importance; all the more so as it has apparently been overlooked in discussing problems like those we are confronted with in our case. The length-height index, like others, only makes sense if it is discussed in connection with the maximum length of the skull. The maximum length of the Uzbekistan Skull is 185 mm; that of the La Quina child is only 171 mm. None of the recent children's skulls which I have re-

ferred to above reaches the length of the Uzbekistan Skull; the longest is only 172 mm. The skulls of adult Neanderthalians, so far as they are known, are, of course, much longer than the Uzbekistan Skull; only the Tabūn I Skull is shorter, its maximum length being 183 mm. But in this adult female skull the total height is 115 mm. and the auricular height is 98 mm. That is considerably less than in the Uzbekistan Skull, in which the corresponding figures are 132 mm. and 113 mm. More than this, none of the adult Neanderthalian skulls reaches the basi-bregmatic height of the Uzbekistan child. Their minimum-maximum values are 115–131 mm., with an average of 125 mm. On the other hand, adult Buriat and Kalmuck skulls of today which have the same maximum length as the Uzbekistan child may show the same height as the latter (table 1).

TABLE 1

SPECIMEN	AGE	MAXIMUM LENGTH	BASION-BREGMA HEIGHT	LENGTH-TOTAL HEIGHT INDEX
Uzbekistan male	8–9 yrs.	185	132	71.2
Buriat[1] no. 236 female	adult	186	132	71.0
Buriat no. 248 male	adult	185	131	70.9
Kalmuck[1] no. 253, male	adult	186	132	71.0
Kalmuck no. 266 male	adult	184	131	71.2

[1] The measurements of the Buriat and Kalmuck Skulls after J. Fridolin ('02).

Therefore, unless there is not a real decrease in the absolute basi-bregmatic height of the Neanderthal skulls during their growth between the years of 9 to 20, of which there is, so far, no indication or evidence, the Uzbekistan child cannot be claimed as a Neanderthalian on account of the lowness of the braincase (Debetz' statement no. 2).

I am unable, because of the dearth of adequate material, to tell whether the angle of inclination of the frontal squama (Schwalbe's bregma angle) which is 56° in the Uzbekistan skull according to my measurement, and the occipital curvature angle which is 119° are so large (the first surpassing the average angle of adult Neanderthal skulls by 11° and the second by 8–9°) only because the Uzbekistan skull is that of a child. The angles cannot be checked on the skull of the La Quina child for its occipital portion which carries the inion is not pre-

served, and in the Mousterian youth the bregma angle is much smaller totaling only 49° while the occipital angle is larger (about 124°); however in both cases the minimum values of adult modern man are 42° and 111°, respectively.

The supraciliary ridges are well developed in the Uzbekistan child and are certainly more pronounced than they are in the skulls of any children of modern man of the same age. Nevertheless, it is impossible to say with any certainty that the ridges may have reached in their adult stage the form, size and heaviness of the supraorbitals of typical Neanderthalians. Upper Palaeolithic skulls, like those of the man of Predmost, Obercassel and the Upper Cave of Choukoutien have very strong supraorbitals. On the other hand, the Skhūl skulls of the Mount Carmel population have these structures to no less an extent than the European Neanderthalians, although they represent undoubtedly a more advanced stage than the latter. Nevertheless, in the Shkūl population of Palestine the mandible has a chin as it occurs in modern man. The Skhūl skulls, therefore, combine Neanderthalian characteristics (heavy supraorbitals) with those of modern man (existence of a trigonum mentale).

This leads us to the question about the character of the mandible of the Uzbekistan child. Both Okladnikoff and Debetz claim that the mandible exhibits no projection of the chin. I regret to have to contradict this statement. It is true that the front part of the mandible as a whole is flat and its basal part not as prominent as is usual in modern man. In other words there is no distinct "mentum osseum" (cf. Weidenreich, '36). But neither is there a receding chin as is found in the Neanderthalians; instead there is a very clear mental trigonum consisting of a well developed tuberculum symphyseos and a distinct lateral tubercle on either side. On the lingual side there is also a projecting mental spine. The age of the individual is unimportant in this case for the mental trigonum is already developed in children of modern type with milk dentition. In the Uzbekistan child the flatness of the front of the mandible is accentuated by a strong bulging of the lateral parts caused by the germs of the permanent canines which are retained in their alveoli. The presence of a chin in the Uzbekistan child is also revealed by a mid-sagittal section through the symphysis (fig. 2b). The anterior outline shows that not only is the mental trigonum developed but also the incurvatio mandibularis above the trigonum and below the incision. The difference between the Sinanthropus child B I (e), the Ehringsdorf child (d) and the Mousterian youth (c) is obvious. The section through the mandible of the adult Skhūl V (a) is also depicted. The angle of inclination of the incision-gnathion line toward the alveolar

plane is 65.5° in the Uzbekistan mandible against 63° in Sinanthropus, 65° in Ehringsdorf, 70° in the Mousterian youth and 68° in Skhūl V.

Besides the development of a chin, the sequence in which the upper and lower permanent teeth of the Uzbekistan Skull erupt is not that of a typical Neanderthalian. This fact has been overlooked by Debetz. A. Schultz ('35) has shown that in all primates, except man, the second molars erupt immediately after the eruption of the permanent incisors. In the Neanderthalians, as shown by Gorjanovič-Kramberger ('06) and H. Virchow ('20) the second molar erupts before the premolars. In Sinonthropus the same holds good (Weidenreich, '37) and even in the Palaeolithic man of Akalou, according to H. Vallois ('34). In modern man the second molar erupts after the premolars and the canine.

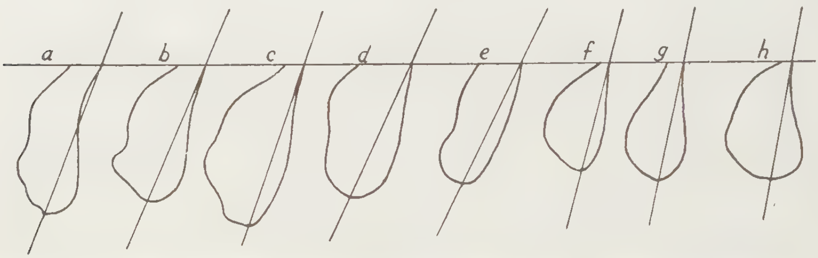

Fig. 2 Mid-sagittal diagrams through the symphysis of the mandible of Skhūl V (a), Uzbekistan Child (b), Mousterian Youth (c), Ehringsdorf Child (d), Sinanthropus Child B I (e), Gibraltar Child (f), North Chinese Child (g), Siamese Child (h).

(a) is a copy from McCown and Keith, reduced a little more than one-half of natural size; (b) is taken from the east; (c) is copied from H. Weinert; (d) from H. Virchow. For other diagrams see Weidenreich, '36, figure 69. b-h in natural size. The horizontal line is the alveolar plane. The oblique lines are the incision-gnathion lines.

In the lower jaw of the Uzbekistan child the permanent incisors and the first molars are in place. But the milk dentition is still represented by the two milk molars and the canine. In the upper jaw the same conditions occur, only the first milk molar has fallen out. The canines and the first premolars are on the point of eruption and more advanced in the upper than in the lower jaw. But the second molars are still deeply embedded in their sockets in both jaws and do not show any indication of erupting. It follows from this fact that the sequence of eruption is that of the modern human type and not that of the Neanderthalians. Unfortunately, we do not know how the conditions of the Skhūl population have been in this regard.

The teeth of the Uzbekistan child are large (Debetz statement no. 8) but they are not beyond the maximum size of those of modern man.

As to the face, Debetz considers a flattened maxilla without a canine fossa as characteristic of Neanderthal skulls (Statement no. 6). In my paper on the Sinanthropus Skull ('43; pp. 77, 78) I have discussed the morphology of this fossa. I said there: "The absence is not necessarily a sign of primitiveness." The extent to which the molar region is "inflated" in the Uzbekistan Skull is difficult to determine because it is considerably damaged on both sides and the permanent canines cause a considerable bulging of the alveolar portion. McCown and Sir Arthur Keith ('39) report on the appearance of the Skhūl Skull IV, in which the molar region is preserved, as follows: "the . . . maxillary element is nearly vertical and in its contour continues outwards the sub-orbital area of the maxilla, which is also flat, being neither hollowed as in modern skulls nor inflated and convex as in the Gibraltar skull . . . "

If all these facts are taken into consideration, it seems to me that the Uzbekistan child represents rather a hominid type like that of the Skhūl population of Palestine than the European form of the Neanderthalians. In addition, there are certain features not mentioned in Debetz' paper which indicate a trend to Mongolian racial characteristics in the Uzbekistan skull. The most conspicuous is the extreme shovel-shaped form of the upper lateral permanent incisors, which occurs also in the Mount Carmel population (McCown and Keith). Furthermore, the orbital index is 89.3 (orbital height: 33 mm.; orbital width: 37 mm.); this is a very high index. But it must be taken into consideration that the index decreases when the individual grows older; the height of the orbit is especially involved by the expanding of the maxilla and grows smaller with age. Therefore, the index also becomes smaller. However, the interorbital index behaves differently; it seems to be more stationary and less affected by the enlargement of the face than the orbital index. The interorbital width of the Uzbekistan skull is 22.5 mm. and the biorbital width 95 mm. The index is 23.7. In the La Quina child the orbital height is 32 mm., the orbital width 34 mm.; the interorbital width 14 mm., and the biorbital width 82 mm. The orbital index is therefore, 94.4 and the interorbital index 14. All figures are according to H. Martin ('23). In the Mousterian youth the orbital index is 100, and the interorbital index is 23.7 (H. Weinert, '25). The measurements of the orbits of the Uzbekistan skull are not significant. Only the interorbital width is significant; it indicates that the Uzbekistan type belongs to a hominid group with a very broad nasal root no matter whether it is a typical Neanderthalian or a form closer to modern man.

But the form of the nose itself implies a more definite hint. According to Debetz the height of the nose is 44 mm., the width is 29 mm.

and the nasal index is 66.1. As the left part of the rim of the apertura piriformis is broken off, the width can only be estimated. According to my computation the width was not greater than 27 mm. The nasal index, therefore, is only 61.3. However this may be, this is a very high nasal index; it shows that the face has to be grouped with the hyperchamaerrhines. In the La Quina child the nasal index is only 49.5, and in the Mousterian youth according to Weinert's estimation, only 50.0. None of the adult Neanderthalians has such a high index, or in other words such a broad nose.

As to the maxillary prognathism, it is impossible to advance an opinion about its definitive character on the basis of the conditions of the child, for they change with the growth of the face. The nasion angle of the upper facial triangle of the Uzbekistan skull is 67°, in the La Quina child the angle is 62°, and it is 73° in the Mousterian youth. In the adult Mount Carmel population the angle varies from 60° (Tabūn I) to 81° (Skhūl V), and in modern man from 54° to 76°. The greater the angle the greater the prognathism.

As I have said earlier, I do not consider as proven that the Uzbekistan skull is that of a Neanderthalian of the Mousterian European type. I do not feel competent enough to argue about its geological age, but the fauna and the cultural indications are not incompatible even with Late Upper Paleolithic times. Judged from the morphological point of view the skull may belong to an advanced hominid type intermediate between the classic Neanderthalian and modern man like the Mount Carmel population of Palestine, but at the same time the face and dentition exhibit some Mongoloid trends.

The dubious character of the Uzbekistan Skull reminds us of other finds on Russian soil which have been too long and quite wrongly neglected. I refer in particular to the Podkumok skull fragments described by M. A. Gremiatsky ('22, '25). It is true that very few parts of the skull are preserved. But the frontal bone shows a very characteristic feature, namely, well developed tori supraorbitali which are connected with each other by a typical glabellar torus. On the other hand, the fragment of the mandible does not include the front portion. Gremiatsky considered the frontal bone as of a Neanderthal type and the lower jaw as of one intermediate between "Homo neanderthalensis and Homo sapiens." In my paper on the Ehringsdorf skull ('28) I called special attention to the Podkumok fragment, because the frontal bone recalls conditions of the Ehringsdorf skull, and both together the Galilee Skull. However, my call remained unanswered. Sir Arthur Keith seems to have killed the Podkumok Skull with his remark in the "New Discoveries"

('30): "Those familiar with the diagnostic features of Neanderthal man have only to examine the illustrations to be convinced that Podkumok man was altogether of the Neanthropic species." It is true Gremiatzky's illustrations show the frontal bone not in a very favorable orientation and aspect and the reproduction is poor; but this does not justify Keith's condemnatory verdict. In particular since we have been acquainted in the meantime by Keith himself with hominid types which exactly correspond to those Gremiatzky had in mind when he studied the Podkumok finds. I have the impression that the Podkumok Skull comes close to the Galilee Skull and the skulls of the Mount Carmel population and therefore, urgently deserves to be reexamined.

The Uzbekistan Skull, the Mount Carmel skulls and possibly the Podkumok Skull represent forms which fit in between the Neanderthalian (Mousterian) stage of human evolution and that of modern man (Homo sapiens). The Uzbekistan Skull has been recovered from Central Asia, the Mount Carmel skulls from Palestine and the Podkumok Skull from a river bank between the Black and Caspian Seas north of the Caucasus. These localities suggest that intermediate types may be expected all over Western and Central Asia. There and not in Europe the transformation of the Neanderthalian into modern man may have taken place. The gap which separates the European Neanderthalian from Homo sapiens and led to the deduction that the former has become extinct without leaving behind any descendants, seems to exist only in Western and Central Europe. Toward the East intermediate forms emerge which bear witness to the continuation of the human line of evolution.

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PLATE 1

EXPLANATION OF FIGURES

The skull of the Uzbekistan Child in four views (norma lateralis dextra; norma frontalis; norma occipitalis; norma basalis). Photographs from the original taken by N. S. Sinelnikov. Reduced a little less than one-third.

BIRTH SEX RATIOS IN THE TOTAL, THE "WHITE" AND THE "COLORED" U. S. POPULATIONS [1]

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The birth sex ratios of the U.S. population as well as those of other countries are important data for the anthropologist, the sociologist, the economist, and for the biologist who is interested particularly in the biology of man. Because this is true and has been true for a long time it is surprising to find an almost complete lack of readily available and analyzed U.S. birth sex ratio data in the literature. Ciocco ('34) has presented the most inclusive lists and has treated very competently the relationships and implications of the data which he submitted, but he did not include all the basic information that we must have available. Strandskov ('42) dealt briefly with the variance of live birth sex ratios. He omitted, however, stillbirths and total births and for this reason, at least, his data are deficient. Others have submitted general statements and short lists but none which are analyzed statistically or are satisfactory for a detailed analysis. In this paper we have brought together from census reports, (1) the yearly total birth frequencies (i.e. all live births and stillbirths combined), (2) the yearly live birth frequencies, and (3) the yearly stillbirth frequencies of the U.S. Birth Registration Area from 1922 to 1936 inclusive. We have also separated out and presented corresponding frequencies for the "white" and the "colored" populations considered independently. For all of these nine different populations we have calculated sex ratios and have subjected these to certain statistical treatments.

We have already in a previous publication (Strandskov, '45) given reasons why we have chosen the interval 1922 to 1936. In that paper we discussed the plural birth frequencies of the U.S. population for the indicated interval. In future papers we hope to analyze many other biological aspects of our national population and eventually to compare all of these data in detail with corresponding data for the populations of other countries.

[1] It is a pleasure for the author to express his appreciation to Prof. Sewall Wright for suggestions and criticisms.

In table 1 are presented the yearly total numbers of all births (i.e. all live births and stillbirths combined) in the U.S. Registration Area for the years 1922 to 1936 inclusive. Such total birth data (i.e. including stillbirths) are frequently absent from discussions pertaining to population problems, but to those of us who are interested in the biology of man they are basic information. We mentioned that we were presenting in table 1 a list of the frequencies of all births. This statement is not quite correct because we have omitted those stillbirths for which the sex is not recorded. This number is not large but a few are reported each year. We mention this fact because someone may find that the frequencies we report may not agree exactly with data published elsewhere. Our totals are only of those for which the sex was recorded.

TABLE 1

Sex ratios of the total population (live births and stillbirths combined) in the U.S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	TOTAL NO. OF BIRTHS (LIVE AND STILL COMBINED)	NUMBER OF ♂	% ♂
1922	1,843,756	951,503	51.067
1923	1,861,447	960,586	51.604
1924	2,005,130	1,035,614	51.646
1925	1,949,266	1,007,360	51.679
1926	1,925,623	993,447	51.591
1927	2,219,464	1,146,437	51.654
1928	2,321,510	1,198,291	51.617
1929	2,254,040	1,162,888	51.591
1930	2,289,021	1,180,580	51.576
1931	2,191,783	1,129,494	51.533
1932	2,150,848	1,107,558	51.494
1933	2,156,670	1,111,728	51.548
1934	2,244,541	1,156,471	51.524
1935	2,230,608	1,148,147	51.472
1936	2,217,066	1,140,357	51.435
Total	31,860,773	16,430,417	773.571
Mean	2,124,051	1,095,361	51.571

The term stillbirth as used here must be defined. Unfortunately this term has no single meaning in U.S. census reports. In some states all products of conception must be recorded. Therefore many of the stillbirths from those states represent early rather than full term or late developmental stages. In other states stillbirths include only such fetuses as have reached the fifth month of uterogestation. In still other states they include only those fetuses which have reached the 7- or 8-month stage. When drawing conclusions on a basis of U.S. census

stillbirth records it is important that these facts be kept in mind. (For further details on variations in recording policies see U.S. census reports.)

From an inspection of table 1 it will be seen that the unweighted mean of the 15 yearly birth sex ratios of the total U.S. population from 1922 to 1936 is 48.429% ♀ : 51.571% ♂. The actual sex ratio for the total population of 31,860,773 births for this interval is 48.431% ♀ : 51.569% ♂.

One of the questions which we are interested in asking is, why this observed birth sex ratio? Is there any theoretical reason for expecting this particular ratio or is there more reason for expecting some other one? The birth sex ratio expected depends upon the manner in which sex is determined. If it is completely genetically determined the most logical ratio is a 50:50 one. If it is not genetically determined or only partially so almost any other ratio might be expected. According to the best available evidence sex in man is 100% genetically determined. By this we mean that it is entirely a function of the hereditary materials which are brought together at the time of fertilization. The evidence on the basis of which this conclusion is drawn is the fact that females have been shown to possess two X-chromosomes and twenty-three pairs of autosomes, whereas males have been shown to possess an X- and a Y-chromosome plus twenty-three pairs of autosomes. This evidence has been presented primarily by Winniwarter ('12), Painter ('23), Oguma and Kihara ('23), and by Evans and Swezy ('29).

If we expect a 50:50 ratio a logical question to ask is, does the observed birth sex ratio of the total U.S. population deviate significantly from the expected one? This question can best be answered statistically by applying the usual formulae for the testing of the significance of the deviation of an observed ratio from an expected one.

$$\text{S.E. ratio} = \sqrt{\frac{\text{P.q}}{\text{N}}} = \sqrt{\frac{.50 \times .50}{31{,}860{,}773}} = .0000886$$

$$\frac{\Delta}{\text{S.E.}} = \frac{.01569}{.0000886} = 177.$$

Since the difference between the expected and the observed ratio is many times greater than the standard error of the expected, there is no question but what the observed ratio of the total U.S. population for the interval indicated deviates significantly from a 50:50 one. A difference greater than 2 S.E. is generally considered significant.

Since it is shown that the observed birth sex ratio deviates significantly from a 50:50 ratio, it becomes of interest to decide whether this also is true of the conception ratio. The first suggestion which gen-

erally comes to mind is that the conception ratio is probably a 50:50 one but that more females than males die in utero. Although this conclusion appears logical it is not supported by facts. At least all records indicate that more males than females die during those stages of the gestation period when the sex can be determined. Hence the conception sex ratio appears to be distorted in favor of males even more than is the birth ratio. For the U.S. population as a whole the conception ratio may be close to 48% ♀ : 52% ♂. The problem of accounting for the observed birth sex ratio, therefore, appears to be one of accounting first of all for the conception of more males and secondly for the higher death rate among males during the later stages of the gestation period. There remains the possibility that more females than males die during the early developmental stages, i.e., before sex can be determined accurately by the physician.

We have no good data on the basis of which to account for a divergent conception sex ratio favoring males. However, it is of interest to consider possibilities. At least three plausible hypotheses have been suggested. One is that male determining sperms are more mobile than female determining ones and therefore that more of them reach the upper ends of the oviducts in time to fertilize the eggs. Another is that female determining sperms with an X-chromosome carry more genes which tend to be lethal to gametes than do male determining sperm with a Y-chromosome. A third possibility is that female determining sperms, for reasons other than the ones already indicated, have a lower survival value than do male determining sperms in the chemical environment of the female genital tract. Although all of these hypotheses are attractive there is no specific evidence which favors any one of them.

The greater number of deaths among male than among female embryos during early developmental stages has been attributed to recessive sex linked lethal genes. Such genes it is true should tend to kill off more males than females, but there is very little direct evidence that such genes exist. Another possibility is that the male embryo, by virtue of the fact that it is a male, has a lower survival value in the environment of the uterus than does the female. Again, however, we must repeat that very little specific information can be presented in support of the suggested hypothesis.

Whatever the various factors are which are responsible for the deviation of the birth sex ratio from the expected, one thing is certain and also remarkable and this is that these factors are continually present and produce unusually simliar effects from year to year. During every year of the 15-year interval included in this study the birth sex ratio

has been tested and shown to deviate significantly from a 50:50 ratio and always in favor of males.

In order to learn something about the factors which cause the sex ratios to deviate regularly and significantly from an expected 50:50 ratio it is of interest to find out if the variability of the yearly sex ratio falls within or outside the range expected if chance factors alone were operating. This question can be answered by comparing the observed variance with that expected due to chance. The observed variance

$$\sigma_o^2 = \frac{\Sigma \text{ fd}^2}{N - 1} = \frac{.00000679}{14} = .0000004851$$

The variance of a ratio due to chance is given by the formula $\frac{p.q}{N}$ where p and q are the percentage frequencies of the ratio and N is the number of individuals involved. In this instance we have used the sex ratio of the total population as p and q and the average number of individuals per year as N. Thus the variance of the observed male percentages due to chance

$$\sigma_T^2 = \frac{p.q}{N} = \frac{.48429 \times .51571}{2,124,051} = .0000001176$$

If we compare the observed variance (σ_o^2) with that expected on a basis of chance (σ_T^2) we find that the former is 4.12 times greater than the latter. As we pointed out in our previous paper Fisher has furnished us with a method whereby it is possible to determine the probability of getting one variance a certain number of times greater or smaller than another. He has called the extent to which one is greater or less than another the statistic F. Snedecor has prepared a table of probabilities of F values. Employing this table we find that when the smaller of the two variances has 14 degrees of freedom and the larger one an infinite number, an F value of 4.12 has a probability considerably smaller than .05. (F 1.69 has a probability of .05 and F 2.07 has a probability of .01.) Hence since the calculated F value has a probability less than .05 we may conclude that the yearly sex ratios of the total population of the U.S. Birth Registration Area vary significantly more than may be attributed to chance. What the factors are which are responsible for the greater variability is not evident. It is possible that they may involve genetic heterogeneity. If different genetic groups contributed unequal proportions at different times during the interval studied the result which is observed might be expected. Because of a gradual extension of the Birth Registration Area this is a possible explanation. Another possibility is that economic and other environmental factors might affect the number of males which die during the

uterogestation period and hence affect the birth sex ratio. It will be remembered that not all states include early stillbirths in their reports.

In table 2 the yearly total births are subdivided into live births and stillbirths. The total number of live births for the 15-year interval is 30,713,547 of which 15,774,412 are males. The live birth sex ratio for the total period is therefore 48.640% ♀ : 51.360% ♂. Although this sex ratio does not diverge quite as far from a 50 : 50 ratio as does that for all births it definitely represents a highly significant deviation. It is 151 times the standard error of the expected ratio.

TABLE 2

Sex ratios of live births and of stillbirths of the total population in the U.S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	LIVE BIRTHS		STILLBIRTHS	
	No.	% ♂	No.	% ♂
1922	1,744,911	51.373	68,845	57.625
1923	1,792,646	51.378	68,801	57.508
1924	1,930,614	51.405	74,516	56.892
1925	1,878,880	51.465	70,386	57.379
1926	1,856,068	51.379	69,555	57.234
1927	2,137,836	51.421	81,628	57.762
1928	2,233,149	51.390	88,361	57.340
1929	2,169,920	51.376	84,120	57.149
1930	2,203,958	51.361	85,063	57.139
1931	2,112,760	51.326	79,023	57.059
1932	2,074,042	51.295	76,806	56.861
1933	2,081,232	51.358	75,438	56.811
1934	2,167,636	51.333	76,905	56.912
1935	2,155,105	51.296	75,503	56.498
1936	2,144,790	51.262	72,276	56.578
Total	30,713,547	770.418	1,147,226	857.747
Mean	2,047,569	51.361	76,481	57.183

If we compare the observed variance of the yearly live birth sex ratios with that expected due to chance we obtain an F value of 2.26. This value has a probability somewhat less than .05. It is not, however, as low as the probability of the F value for the sex ratios of all births. Consequently we may conclude that the yearly live birth sex ratios also vary during the 15-year interval more than may be attributed to chance factors operating alone, but that they do not vary quite to the extent as do the yearly sex ratios of all births.

The total number of stillbirths as shown in table 2 is 1,147,226. Of these 656,005 are males. This gives a stillbirth sex ratio of 42.818% ♀ : 57.182% ♂ for the total 15-year period. Although the number of indi-

viduals involved in the stillbirth data is relatively small the observed deviation of the stillbirth sex ratio from a 50 : 50 ratio is also a highly significant one. It is 154 times the standard error of the expected ratio.

With respect to the variability of the yearly stillbirth sex ratios we find that the observed variance is 5.30 times greater than that expected due to chance. This value has a probability considerably below .05. Hence we may conclude that the yearly stillbirth sex ratios likewise vary more may be attributed to chance. They vary somewhat more than do those of the total births of the population (i.e. live births and stillbirths combined) and considerably more than do those of live births considered alone.

We have already indicated that the live birth sex ratio of the total population is 48.640% ♀ : 51.360% ♂ and that that for stillbirths is 42.818% ♀ : 57.182% ♂. It is of interest to find out if these two ratios are significantly different. This can be done by applying the usual formula for a test of the significance of the difference between two means.

$$t = \frac{\Delta}{\sqrt{\frac{\Sigma(x_1 - \bar{x}_1)^2 + \Sigma(x_2 - \bar{x}_2)^2}{N_1 + N_2 - 2} \times \frac{N_1 + N_2}{N_1 N_2}}}$$

If we apply this formula we obtain a *t* value of 54. With 28 degrees of freedom a *t* value of only 2.05 has a probability of .05. Hence the two distributions which are compared may be considered significantly different, that is they may be considered samples of different populations. A significantly higher percentage of males among stillbirths than among live births means of course that proportionately more males die at birth or during the gestation period than is true for females. As we have already indicated there exists no completely satisfactory explanation for this greater death rate among males in utero.

From a genetic point of view it is of special interest to separate the total births of the U.S. population into as many genetic subgroups as possible and to compare the sex ratios of these groups. As we pointed out in our previous paper ('45) the census data up to 1936, unfortunately do not permit any extensive genetic subdivision. The only separation that can be made is the bifurcation of the total birth data into "white" and "colored". The "white" group includes mostly Caucasoid stock. The "colored" group is a mixture of Negroid, Mongoloid, and probably some Caucasoid stock, but Negroes quite certainly contributed each year more than 90% of the total.

In tables 3 and 4 are presented the total birth (i.e. live births and stillbirths combined), the live birth, and the stillbirth frequencies of the

TABLE 3

Sex ratios (1) of all "white" births (live births and stillbirths combined), (2) of "white" live births, and (3) of "white" stillbirths in the U.S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	"WHITE" BIRTHS (LIVE AND STILL COMBINED)		"WHITE" LIVE BIRTHS		"WHITE" STILLBIRTHS	
	No.	% ♂	No.	% ♂	No.	% ♂
1922	1,687,719	51.634	1,629,387	51.420	58,332	57.589
1923	1,702,315	51.619	1,644,034	51.410	58,281	57.499
1924	1,824,842	51.667	1,762,872	51.445	61,970	57.976
1925	1,791,547	51.693	1,731,669	51.497	59,878	57.350
1926	1,765,962	51.609	1,707,034	51.416	58,928	57.192
1927	1,991,720	51.689	1,925,585	51.480	66,135	57.773
1928	2,050,527	51.666	1,982,246	51.479	68,281	57.098
1929	1,989,414	51.619	1,924,475	51.433	64,939	57.144
1930	2,012,000	51.615	1,946,841	51.432	65,159	57.105
1931	1,908,749	51.582	1,848,293	51.405	60,456	56.984
1932	1,862,980	51.506	1,805,155	51.342	57,825	56.604
1933	1,851,303	51.601	1,794,946	51.444	56,357	56.612
1934	1,923,427	51.551	1,866,231	51.397	57,196	56.562
1935	1,945,495	51.520	1,888,012	51.372	57,483	56.377
1936	1,936,869	51.491	1,881,883	51.349	54,986	56.340
Total	28,244,869	774.062	27,338,663	771.321	906,206	856.205
Mean	1,882,991	51.604	1,822,577	51.421	60,413	57.080

TABLE 4

Sex ratios (1) of all "colored" births (live births and stillbirths combined), (2) of "colored" live births, and (3) of "colored" stillbirths in the U.S. Birth Registration Area from 1922 to 1936 inclusive.

YEAR	"COLORED" BIRTHS (LIVE AND STILL COMBINED)		"COLORED" LIVE BIRTHS		"COLORED" STILLBIRTHS	
	No.	% ♂	No.	% ♂	No.	% ♂
1922	156,037	51.316	145,524	50.846	10,513	57.824
1923	159,132	51.452	148,612	51.019	10,520	57.557
1924	180,288	51.435	167,742	50.983	12,546	57.476
1925	157,719	51.523	147,211	51.093	10,508	57.467
1926	159,661	51.396	149,034	50.964	10,627	57.467
1927	227,744	51.344	212,251	50.879	15,493	57.716
1928	270,983	51.247	250,903	50.693	20,080	58.162
1929	264,626	51.382	245,445	50.930	19,181	57.166
1930	277,021	51.289	257,117	50.827	19,904	57.250
1931	283,034	51.207	264,467	50.778	18,567	57.306
1932	287,868	51.419	268,887	50.979	18,981	57.647
1933	305,367	51.227	286,286	50.815	19,081	57.397
1934	321,114	51.361	301,405	50.932	19,709	57.928
1935	285,113	51.146	267,093	50.759	18,020	56.887
1936	280,197	51.052	262,907	50.639	17,290	57.334
Total	3,615,904	769.796	3,374,884	763.136	241,020	862.664
Mean	241,060	51.320	224,992	50.876	16,068	57.511

"white" and the "colored" populations considered separately. Also shown are the percentages of males born each year within each group.

For each of the six populations which are presented the observed birth sex ratio has been tested for significance of deviation from a 50:50 ratio. Likewise the yearly birth sex ratios of each of the six populations have been tested for variability as it relates to that due to chance. The results of all of these twelve tests, as well as those of the six which involve the total population, are given in table 5.

TABLE 5

Results of t and F tests applied to the sex ratios of different populations of the U.S. Birth Registration Area for the year 1922 to 1936 inclusive.

POPULATION TESTED	t VALUE OF DEVIATION OF OBSERVED SEX RATIO FROM EXPECTED 50 : 50 RATIO. (t 2 = PROB. .05)	F VALUE OBTAINED FROM COMPARISON OF OBSERVED VARIANCE AND VARIANCE EXPECTED DUE TO CHANCE. (F 1.69 = PROB. .05)
Total births (live and still combined)	177.	4.12
Total live births	151.	2.26
Total stillbirths	154.	5.30
"White" total births (live and still combined)	171.	3.08
"White" live births	149.	1.50
"White" stillbirths	135.	6.29
"Colored" total births (live and still combined)	50.	1.54
"Colored" live births	32.	1.68
"Colored" stillbirths	74.	1.49

An inspection of table 5 will reveal that all of the sex ratios of the "white" and the "colored" populations deviate significantly from a 50:50 ratio, as was shown previously to be true for the three corresponding groups of the total population. The sex ratios of the "colored" total births and the "colored" live births are closer to a 50:50 ratio than are the corresponding ones of the "white" population. That for "colored" stillbirths deviates more than does the corresponding one for "white" stillbirths. Its t value is smaller but this may reasonably be attributed entirely to the smaller number of individuals involved.

The F values presented in table 5 show that the yearly sex ratios of the total births, total live births, total stillbirths, "white" total births, and "white" stillbirths vary more than may be attributed to chance, whereas those of "white" live births, "colored" total births, "colored"

live births and "colored" stillbirths do not. The small F values for the three "colored" populations probably are primarily a consequence of small numbers.

We have already shown that the means of the yearly percentages of the total births (i.e. of live births and stillbirths of the total population combined), of the total live births, and of the total stillbirths differ significantly. In table 6 are given the t values of these tests as well as the t values of similar tests applied to "white" and to "colored" population means. Since a t value of 2.05 has a probability of .05 all the means compared are shown to be significantly different. The percentage of males of white total births (live birth and stillbirth combined), and of "white" live birth are significantly higher than the corresponding percentages of the "colored" population. The "colored" stillbirths, however, have a higher representation of males than do "white" stillbirths. This last mentioned difference is not shown to be large but it becomes more striking when we take into consideration the fact that the "colored" total birth and the "colored" live birth sex ratios are closer to a 50 : 50 ratio than are the corresponding ones for the "white" population.

TABLE 6

Comparisons of the means of the sex ratios of different populations with the U.S. Birth Registration Area from 1922 to 1936 inclusive.

POPULATIONS COMPARED (THE POP. WITH LARGER PERCENTAGE OF MALES IS SHOWN FIRST).	t VALUE OF DIFFERENCES. (t 2.05 = PROB. .05)
Total still — Total live	54.31
"White" still — "White" live	43.23
"Colored" still — "Colored" live	73.97
"White" total — "Colored" total	7.76
"White" live — "Colored" live	14.65
"Colored" still — "White" still	2.80

SUMMARY

1. The yearly birth (live birth and stillbirth combined) sex ratios, the live birth sex ratios and the stillbirth sex ratios of the total, the "white" and the "colored" populations of the U.S. Birth Registration Area from 1922 to 1936 inclusive, are presented.

2. The observed sex ratio of each of the nine different populations indicated in no. 1 is shown to deviate significantly from an expected 50 : 50 ratio.

3. The yearly percentages of males of the total births, total live births, total stillbirths, "white" total births, and "white" stillbirths

for the interval indicated vary more than may be attributed to chance factors. Those of "white" live births, "colored" live births and "colored" stillbirths do not.

4. The sex ratios of all the different populations are compared with one another stastically. Most of them are found to be significantly different. Most importantly it is found that the percentage of males among "white" live births is significantly higher than the corresponding percentage among "colored" live births, and that the percentage of males among "white" stillbirths is significantly lower than the corresponding percentage among "colored" stillbirths.

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SKELETAL REMAINS FROM PRINCE WILLIAM SOUND, ALASKA

(Continued)

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FIVE TEXT FIGURES AND ONE PLATE

MANDIBLE

Gnathoscopic observations

General character and appearance. Aside from the sex morphological differences obtaining in the lower jaws of the human varieties, it is their general character and appearance from the viewpoint of massiveness as well as of comparative morphology which are of typological importance. The lower jaw as one of the most plastic bones of the skeleton offers for this reason a wide range of variational conditions.

The general habitus of the mandibles of our series from the standpoint of sex is distinguished by a certain robustness of texture and shape which is particularly noticeable in the male where it is further emphasized by the massive ramus and the latter's pronounced erectness. The latter to a lesser degree obtains in the female mandible where a more reclining ramus is frequently associated with an antero-posterior dilation of the upper free end of the ramus and anterior distension of the chin region. In contrast to the male the female jaw in lateral aspect affords an expression of slenderness and slopeness. This morphological difference is revealed in figure 8 where the lateral contours of a male (P. V. 1 ♂) and a female (Gl. I. II ♀) mandible have been superposed, leveled on the alveolar plane line (*A–A′*), the two postmolar points coinciding. The characteristic slant is brought out by the pogonion (pg)–condylion superius (cds) line which will be noticed as considerably more inclining in the female than in the male mandible.

Muscular relief. On the average, muscular relief formations show a medium development with an intensification however in the more robust and a noteworthy weakening in the more gracile specimens. The relatively best developed muscle marks are those caused by m. pterygoideus internus whose strain potentially countered by that of

m. masseter causes the everted angles as predominantly found in the male mandible (p. 81). Striae platysmaticae (Virchow, '20, p. 24; see p. 57 and Literature Cited) are fairly absent, although a longitudinal thickening of the outer basal margin of the corpus beginning at the tuberculum mentale and extending into the submolar region (P. V. 1 ♂ and particularly in P. C. B2 ♂) suggests in certain cases a torus platysmaticus (H. Virchow) set off from the adjoining supratoral extension of the outer corpus surface by a groove-like depression along the upper edge of the torus, the so-called sulcus platysmaticus (H. Virchow) or sulcus supramarginalis s. mentalis (Klaatsch). Playing quite a rôle in palaeoanthropological research, the conditions just discussed were recently restated in the Sinanthropus mandibles by Weidenreich ('36) under the name of sulcus intertoralis.

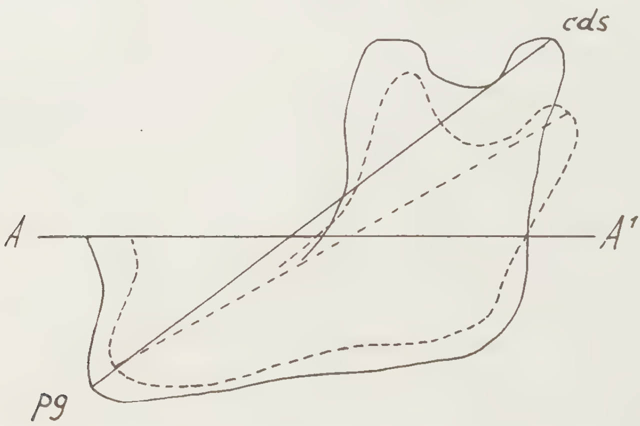


Fig. 8 Superposed mandibular outlines in orthogonal lateral projection (———. Palugwik Village 1 ♂; – – –, Glacier Island II ♀), oriented on alveolar plane line (*A–A'*), the two postmolar points coinciding, to show the different corpus-ramus slant as indicated by the pogonion (*pg*)–condylion superius (*cds*) diameters.

Corpus. Incisurae praeangularis (Frizzi) and submentalis (Klaatsch) are recessions of the basal edge of the corpus. The praėangular incisure occurs just anteriorly of the tuberosities for mm. masseter and pterygoideus internus and its development seems to be proportionate to that of the tuberosities mentioned as well as to the gradual and typical anteroposterior mass diminution of the corpus mandibulae. With a few exceptions (P. C. B2 ♂, P. C. B2 x ♂) where the incisure is more pronounced, its development is rather weak, in a number of cases widely and shallowly extended (P. C. B3 ♀; P. C. C2 ♂ ?) and fairly absent in others (P. V. 1 and 2 ♂). The submental or subsymphysial in-

cisure whose morphogenetic importance was first realized in the Australian mandible (Klaatsch, '09; see p. 57 and Literature Cited) and in the Heidelberg specimen (Schoetensack, '08) is completely absent in our series, but very faintly indicated in P. C. C2 ♂ ? and P. E. P. III ♂.

Fossa digastrica and spina interdigastrica (Klaatsch). The grooves for m. digastricus transversely to the midline are only weakly developed as is the spina interdigastrica (Klaatsch)[9] Both formations occur fairly at the underside of the symphysial region which in most cases is conspicuously broadened anteroposteriorly (Area digastrica H. Virchow). Conditions are per se exceedingly variable in this area and dependent to a large extent upon the morphological and functional habitus of m. digastricus whose "anterior belly is the most varying muscle of the body" (Virchow, '20; p. 43; see p. 57 and Literature Cited).

Spina mentalis interna. Exceedingly variable in form and size are also the mm. genioglossus and geniohyoideus insertions superiorly of area digastrica upon the medial side of the symphysial region. It is particularly the genioglossus insertions which are the best developed and known as spina mentalis interna. There is in most cases an individual spina formation for the paired m. genioglossus and a unified tuberosity of varying shape for mm. geniohyoidei. The largest spinae in our series are those of P. C. A ♂.

Foveae sublingualis and submaxillaris as well as linea mylohyoidea show no distinctive features, they are of medium development.

Foramen mentale. The size of foramen mentale ranges from small to medium. Multiplicity of occurrence was not observed. The position of foramen mentale, strongly underlying phylogenetic changes, varies even in our small series. While in most cases it lies on a level with Pm_2, either directly or anteriorly of it between Pm_{1-2} or even on a level with Pm_1 (M. I. x ♀; P. C. A ♂; P. C. B2 ♂), it is also found to coincide with the position of M_1 (P. C. B2 x ♂). As exemplified by the palaeanthropological specimens the occurrence of foramen mentale in the molar region is the phylogenetically more primitive condition.

Ramus. The ramus as already mentioned (p. 177) differs by appearance and size in the sexes. Morphologically it is the upper free end which tends to dilate in the female. This is drastically shown in figure 9, *a*, where the condylocoronoid dilation is furthermore emphasized by the markedly widened incisura mandibulae. Of special interest in *b* of the same figure is the posteriorly drawn out and attenuant condyloid

[9] Tuberositas interdigestrica (Virchow, '20, p. 40; see p. 57 and Literature Cited).

process of the female mandible. An almost identical case is pictured by Draper ('30, p. 79) and identified there as the gastric ulcer type of human mandible. This of course cannot be verified in our specimen while the concomitant phenomena of a stronger slant and a greater ramus-body ("posterobasal") angle are unmistakable female characteristics as was shown by the present writer in various studies (see also figure 10 and p. 185).

Incisura mandibulae (condylocoronoidea) is in each case symmetrically formed and from medium deep-to-deep (p. 184), the width differences as stated in the preceding paragraph being in most cases a sex character

Incisurae subcoronoidea and subcondyloidea (Klaatsch). The anterior and posterior constrictions of the ramus are shallow throughout and differ only by their widths under the consideration that the posterior

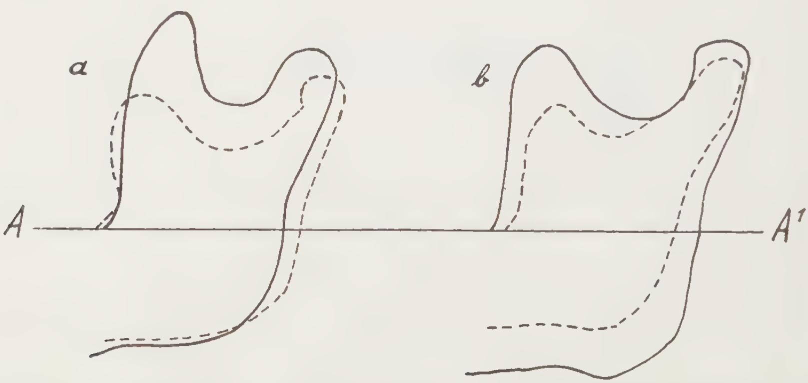


Fig. 9 Ramus outlines oriented on alveolar plane line (A–A') to show sex differences particularly in the free ends. In *a*, Palutat Cave E x ♀ (– – –) is superposed on Glacier Island I ♂ (———); in *b*, Palutat Cave B3 ♀ (– – –) on Palutat Cave B2 ♂ (———).

or subcondyloid margin of the ramus is more extended than the anterior or subcoronoid margin. The dilation of the upper free end of the ramus exercises a certain influence upon the incisures under discussion, i.e., adds somewhat to their depths.

Processus articulares. The sizes as to thickness and length of the condyles are variable as is usually the case, but show no extreme conditions in any of their extensions. This holds true also for the length axes which normally converge posteriorly in their general orientation as well as in that of individual inclination which latter occurs posteriorly and inferomedially. The angles thus formed may vary as to location and size and naturally depend upon the individual orientation of

each condyle. Approximation of the axes in general toward the frontal plane was noticed in P. C. C2 ♂ ? and P. C. E x ♀ ?, while those of P. E.P. I show a difference of direction where the left condylar axis retains a direction rather coinciding with the frontal plane, the right one slanting from laterally and before to mesially and behind.

Trigonum postmolare (Klaatsch). The triangular elongation of the posterior margin of the alveolus for M_3 is of phylogenetic interest. Lying in line with the posteriorly extending dental germ layer in the developing mandible, it suggests in the higher primate forms the elimination of a fourth molar. Greatly varying in size and shape it is frequently drawn out into a ridge in the direction of the aforesaid germ layer. Shapes and sizes in our series vary between short and broad

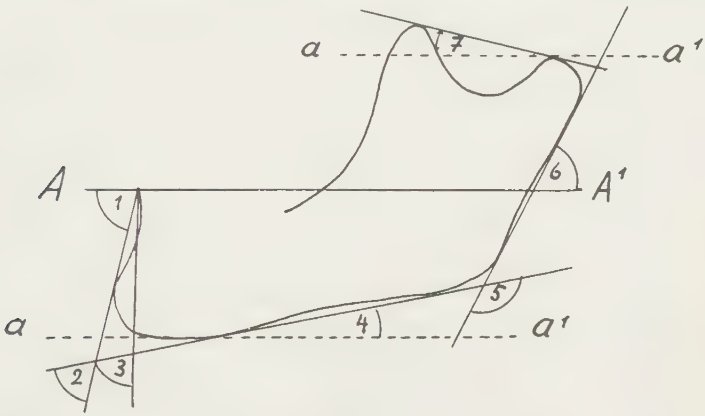


Fig. 10 Scheme of angles in the gnathogram:

A–A', alveolar plane line of mandibular orientation; *a–a'*, any parallel to *A–A'*.

1. Chin angle: Chin tangent and *A–A'* line;
2. Mentobasal angle: Chin and basal tangents;
3. "Anterobasal" angle: Infradentale vertical and basal tangent;
4. Basal angle: Basal tangent and *a–a'* line through lowest point of basal outline;
5. "Posterobasal" angle: Ramus and basal tangents;
6. Ramus angle: Ramus tangent and *A–A'* line;
7. Condylocoronoid angle: Condylocoronoid tangent and *a–a'* line passing through condylion superius.

and between narrow and long while the enclosed triangles show various degrees of ruggedness. Extending ridges were noticed in P. V. I ♂, P. E. P. I ♂ and III ♂ ; an exceedingly long and narrow triangle is present in P. C. B3 ♀.

Medial relief of ramus. The most variable detail upon the medial surface of the ramus is the shape of lingula mandibulae for ligamentum sphenomandibulare; in most cases truncated, it may also be seen

pointed, flap-like, etc. Some variation obtains also in the width and depth of sulcus mylohyoideus which in P. C. C1 ♂ is completely bridged by osseous continuity for about 1 cm. in each ramus and intermittently further downward in the left ramus. The distinct bulges upon the medial surface which continue a torus-like eminence toward the condyloid and coronoid processes are expressive in the specimens of our series of their different osseous voluminosity. This is also true of linea mylohyoidea although the latter's morphological behavior is frequently quite individual.

Dental arch and teeth. The dental arch shows throughout the paraboloid shape which is typical in the human jaw. Occasionally adaptations to various degrees of angularity in the anterior intercanine section of the upper jaw, if any, are witnessed, although they are rarely as pronounced in the mandible (P. C. C2 ♂ ?; P. V. I ♂).

The incisors as far as could be ascertained are shovel-shaped. The number of teeth in the mandibles is complete except for post mortem loss in several of them and for two cases (G. I. I ♂ ? and P. C. B3 ♀) where the third molars have not erupted. The molar teeth appear to be larger and stockier than those of the upper jaw and the phylogenetic trend of diminution of size mesioposteriorly is also less evident in the lower molars.

Pathological conditions are exceedingly rare. Caries is entirely absent. Attrition of the occlusal surfaces has gone quite far in instances and then mostly in the horizontal direction. There is but one case (P. V. 1 ♂, see p. 67) where the abrasion occurred slantingly in the typical Indian way. Extreme attrition seems to be causative in traumatic conditions such as root fistula, and the like. There is only one case (P. V. II ♀) where the two conditions mentioned are associated in the strongly abraded right M_1 whose outer alveolar wall is destroyed.

Metrical observations

The mandibular measurements discussed in the following are assembled in table 7.

In all the absolute measurements except the condylocoronoid breadth the males exceed the females.

Of the two width measurements the bicondylar width, as is the rule in the human mandible, exceeds the bigonial width. The sex averages of the bicondylar width attain in our specimens 125.6 mm. (117–141 mm.) in the males and 123.0 mm. (118–127 mm.) in the females, for the bigonial width 112.9 mm. (99–124 mm.) and 108.6 mm. (100–111 mm.) respectively.

The chin (symphysial) height gives rise to a male average of 37.0 mm. (33–41 mm.) and a female one of 33.3 mm. (29–37 mm.). The corpus height between the deepest recess of incisura praeangularis and the alveolar plane line ranges markedly below the chin height. It attains 28.1 mm. (25–33 mm.) in the males and 24.6 mm. (21–27 mm.) in the females.

TABLE 7

Mandibular measurements.

MEASUREMENT	MALE			FEMALE		
	Cases	Ranges	Average	Cases	Ranges	Average
Width						
Bicondylar	7	117–141	125.6	5	118–127	123.0
Bigonial	7	99–124	112.9	5	100–111	108.6
Height						
Chin	9	33–41	37.0	7	29–37	33.3
Corpus (inc. praeang.)	9	25–33	28.1	6	21–27	24.6
Ramus						
Height	9	53–78	66.0	7	57–63	60.9
Min. breadth	9	34–43	39.6	7	33–42	37.9
Max. breadth	9	41–51	45.7	7	38–48	44.4
Condylocoronoid breadth	9	30–42	35.2	6	33–39	37.2
Inc. mand. depth	9	11–17	14 6	5	10–15	13.6
Indices						
Width	7	81.8–96.1	89.8	5	80.0–90.2	85.1
Ramus	9	54.0–69.8	60.5	7	55.0–70.2	62.4
Ramus breadth [1]	9	81.8–90.2	86.6	7	79.2–92.1	86.0
Angles [2]						
Chin	9	73–90	83.9	5	71–90	79.8
Mentobasal	9	70–82	76.6	5	65–81	70.6
Anterobasal	9	77–88	82.9	5	81–85	82.8
Basal	9	2–13	7.1	5	5–9	7.2
Posterobasal	9	101–125	112.6	5	111–121	117.8
Ramus	9	65–84	74.8	5	67–73	69.4
Condylocoronoid	8	− 3 to + 22	+ 6.3	5	− 16 to + 2	− 2.0

[1] $\frac{\text{Minimum breadth} \times 100}{\text{Maximum breadth}}$

[2] See figure 10 and legend.

Among the ramus measurements it is the height which shows the greatest difference with 66.0 mm. (53–78 mm.) and 60.9 mm. (57–63 mm.) in the sexes. The minimum breadth averages are more approximated with 39.6 mm. (34–43 mm.) and 37.9 mm. (33–42 mm.) in the males and females. The excess of the female over the male condylocoronoid breadth (coronion-condylion superius) already referred to as characteristic in the human mandible (pp. 179, 180–182) is only slight,

but all the more significant in our small series. The male and female averages are as 35.2 mm. (30–42 mm.) to 37.2 mm. (33–39 mm.). Because of the physical size of the lower jaws the proportion is slightly reversed again in the maximum ramus breadth (Hrdlička, '20, p. 20) where the male average comes to 45.7 mm. (41–51 mm.) in contrast to 44.4 mm. (38–48 mm.) in the females. The depth of incisura mandibulae similarly produces an average of 14.6 mm. (11–17 mm.) in the males and 13.6 mm. (10–15 mm.) in the females.

Indices. The proportional difference between the bicondylar and bigonial widths finds its expression in the width index with male and female averages of 89.8 (81.8–96.1) and 85.1 (80.0–90.2). The higher male average is due to the smaller individual differences between the two measurements involved and which on the average amount to 12.7 mm. (5–22 mm.) in the males and 18.4 mm. (12–25 mm.) in the females. The ramus index with 62.4 (55.0–70.2) in the females and with 60.5 (54.0–69.8) in the males attains a higher average in the former. This difference is due to the smaller female ramus height. The ramus breadth index according to the formula $\frac{\text{Minimum breadth} \times 100}{\text{Maximum breadth}}$ which the writer has here introduced as a possible means of demonstrating the morphologically differing breadth conditions, is from the viewpoint of sex methodically as impressive as the dimensions involved. If this is not borne out sufficiently in the present study it may be laid to the paucity of specimens. The index averages amount to 86.6 (81.8–90.2) in the males and to 86.0 (79.2–92.1) in the females.

Angles. The mandibular angles accounted for in this investigation derive from the outline drawings in orthogonal projection into which the horizontal alveolar plane line of orientation according to the present writer's specification had been drawn (see p. 57). The seven angles studied may be seen represented in the drawing and legend of figure 10 and listed in table 7.

The more important among them are the chin angles 1 and 2 which illustrate the chin protrusion by the angular relations of the chin tangent to the alveolar plane line and the basal tangent; angle 6 illustrating the ramus slant with the alveolar plane line, and angle 7 between the condylocoronoid tangent and a parallel to the alveolar plane line laid through the condylion superius (cds)[10] which latter is also its vertex point. According to the height relations between the two ramus processes, the angle is either negative (—) or positive (+), i.e., it is

[10] In accordance with their location, the writer distinguishes between a condylion anterius (cda), posterius (cdp), superius (cds), laterale (cdl), and mediale (cdm).

negative if the coronoid height falls below the condyloid height, and positive under reversed conditions. A third alternative is that of parallelity of height of the two processes.

The chin angle with 79.8° (71°–90°) in the females and with 83.9° (73°–90°) in the males is shown to be somewhat smaller in the former, i.e., the chin is slightly more protruding in the females. It may be pointed out however, that the angle of the chin discussed here does not express the extent of chin development, so that in a chin angle of 90°, as obtains in our series in a number of cases, the chin nevertheless may show marked proportions. Its appraisement is better served by a plumb dropped from the anterior plane line (see fig. 10, angle 3). This vertical demonstrates the protrusion of the chin anteriorly to it and may be clarified still better by a corrective vertical parallel to the former and laid through the deepest point of the incisure above the chin as proposed by Frizzi ('10). In the mentobasal angle the slant of the basal tangent in relation to the alveolar plane line affords a new aspect. The angle averages 76.6° (70°–82°) in the males and 70.6° (65°–81°) in the females and the difference in this particular case is due to varying mutual behavior of the two factors involved. Quite characteristic is the sex difference in the ramus inclination upon the alveolar plane line where the smaller angle with 69.4° (67°–73°) falls to the females against the larger male angle of 74.8° (65°–84°) thus illustrating the more pronounced slant of the ramus in the females. Quite distinctive is also the condylocoronoid relation as expressed by the averages of the condylocoronoid angles which average a positive angle of + 6.3° (− 3° to + 22°) in the males and a negative angle of − 2.0° (− 16° to + 2°) in the females. Of some importance is also the basal angle which signifies the slant of the basal contour upon a parallel to the alveolar plane line laid through the lowest point of that contour. The angles of our specimens do not vary much as to sex, the male average of 7.2° (2°–13°) almost coinciding with the female 7.2° (5°–9°). The "anterobasal" and "posterobasal" angles as introduced by the writer (Oetteking, '25, '30; see p. 57 and Literature Cited) express the relation of the basal tangent to the infradentale perpendicular and the ramus tangent and are supplementary to the angles of ramus inclination and the slant of the basal tangent. The anterobasal angle yields practically equal averages of 82.9° (77°–88°) in the males and 82.8° (81°–85°) in the females. The sex difference is more distinct in the posterobasal angle which involves the different degrees of ramus inclination. The male average of this angle at 112.6° (101°–125°) distinctly contrasts with the female average 117.8° (111°–121°).

THE PATHOLOGICAL CRANIUM FROM GLACIER ISLAND II ♀ JUV–AD.

This cranium, listed and briefly described on p. 59, is distinguished by a number of peculiar features such as the balloon-like distention of the neurocranium indicative of early hydrocephaly and in consequence thereof quite probably the non-ossification of synchondrosis (fissura) sphenooccipitalis. It also causes cryptozygy of the zygomatic arches (see p. 63). The second molars in both jaws are fully erupted and the third molars are well on their way toward eruption; the premolars, also in both jaws are peculiarly primitive in size and relief, while the incisors, shovel-shaped on both their lingual and labial sides, show already distinct attrition of their occlusal edges. They as well as the canines are distinctly trilobate.

The sutures are completely open. Sutura coronalis displays a certain liveliness and interesting twirls in the complicated section; sutura sagittalis shows simpler excursions while those of sutura lambdoidea are quite lively, closely placed and broadly extended. Sutura squamosa is rather simple. The left squama temporalis produces an almost complete frontal process and gives rise to a stenocrotaphic condition (see fig. 6, 1, p. 74).

The skull gives an impression of immaturity especially in its facial region. The orbits show almost perfect ellipses with all the angles of the apertures remarkably smoothly rounded while the margins are sharply molded. The nasal aperture is narrow, ends in its basal midline in a distinct spina nasalis anterior, the inferior piriform margins forming fosae praenasales.

Although most of the measurements of the skull under discussion fall within the metrical ranges of the series, it did not seem advisable to incorporate them with those of the latter for deductory treatment. They may however be found listed with them in the general table of measurements (table 14)[11]. In the reduced table 8 attached here, the most significant measurements of our specimen are assembled, while the male and female ranges of the entire series are added for comparison.

The measurements by which the cranium under discussion differs conspicuously from the rest of the series, are mostly those as concern the enlarged size of the neurocranium. In almost all the absolute measurements assembled in table 8, our specimen, and in many cases quite drastically, exceeds the average values of the series. The metrical differences of greatest account are those of the cranial capacity in

[11] See footnote 4, p. 63, Am. J. Phys. Anthrop., vol. 3, no. 1, 1945.

which with 1725 cc. our specimen exceeds even the male and female ranges of the table. This condition also holds good for the cranial module, the cranial breadth and more or less for the measurements of the forehead. The differences show still better in the indices, particu-

TABLE 8

Comparative measurements: Glacier Island II ♀ juv–ad.

CRANIAL MEASUREMENT	GLACIER ISLAND II ♀ JUV-AD	MALES OF WHOLE SERIES			FEMALES OF WHOLE SERIES		
		Cases	Range	Average	Cases	Range	Average
Capacity	1725	6	1475–1675	1554.2	3	1150–1300	1200.0
Circumference							
Horizontal	528	6	510–540	526.3	4	482–525	496.5
Sagittal	505	6	499–526	512.3	3	468–480	474.7
Transverse (arc)	340	6	300–322	314.8	4	281–321	295.3
Cranial							
Length	176	7	176–192	185.3	4	170–186	175.0
Length of cranial base	98	7	96–107	101.3	3	95–104	98.0
Breadth	166	7	137–148	142.6	4	134–149	139.0
Height	136	7	127–143	135.9	3	123–131	127.7
Height (auricular)	120	6	108–121	117.8	3	107–107	107.0
Frontal chord	135	6	124–137	128.2	4	110–122	117.0
Frontal arc	118	7	107–118	112.5	4	101–110	106.0
Height of forehead (proj. n-b/e-e′)	92	6	81–91	86.7	3	78–82	79.7
Facial							
Length	95	7	95–109	102.9	3	101–103	101.7
Bread (bizygomatic)	136	6	132–156	141.3	4	126–138	132.8
Upper height	74	7	74–84	78.4	3	66–74	70.7
Prognathy							
Facial (ear–eye plane)	88	6	82–88	83.8	3	75–79	77.0
Midfacial (ear–eye plane)	88	6	82–89	84.8	3	77–83	79.3
Alveolar (ear–eye plane)	88	6	78–85	80.5	3	69–77	72.7
Indices							
Cranial module	159.3	7	149.3–158.0	154.6	3	137.0–147.3	142.4
Facial module (upp. h.)	101.7	6	102.0–115.3	107.6	3	99.7–103.3	101.4
Cranial L–Br	94.3	7	73.2–82.4	77.0	4	79.7–80.8	79.4
Cranial L–H	77.3	7	66.2–80.7	73.4	3	71.5–76.2	74.5
Cranial height (Hrdlička)	79.5	7	73.7–90.1	83.2	3	80.4–84.9	83.2
Auricular height	68.2	6	56.3–68.2	63.3	3	62.2–62.9	62.4
Transverse craniofacial	81.9	6	96.4–105.4	99.4	4	92.6–100.8	95.6
Upper facial	54.4	6	51.9–57.0	55.8	3	50.0–58.7	54.0
Gnathic	96.9	7	96.0–104.1	99.7	3	102.0–106.3	103.8

larly the cranial module at 159.3 mm. and the length-breadth index at 94.3 as against averages of 154.6 mm. and 142.4 mm., and of 77.0 and 79.4 in the sexes. The cranial and facial (upper height) modules, if considered by their actual differences, are quite expressive of the dimensional differences between the neuro- and splanchnocranium, when in the Glacier Island II ♀ cranium the difference amounts to 57.6 mm. as against the male and female averages of the series amounting to 47.0 mm. and 41.0 mm.

In its facial dimensions our skull is distinguished by a conspicuously short facial length of 95 mm. as against the serial male and female averages of 102.9 mm. and 101.7 mm., while its breadth and upper height rather hold medium positions.

Remarkable in our specimen is the absence of prognathy, the angular relations between the facial verticals and the ear–eye plane attaining 88° in all three angles and as such expressing orthognathy coincidental with the highest values of the male and female ranges of table 8. Their averages in contrast to the present Glacier Island II ♀ specimen are mesoorthognathous in the males and prognathous in the females, proportions adequately expressed also by the Gnathic Indices.

The skull under discussion is shown in its five normae in plate 6.

CRANIAL SIZE: CAPACITY, CRANIAL AND FACIAL MODULES

The absolute dimensions of a skull, mutual proportioning of measurements in index computations and the study of angular relations between the cranial parts do not and cannot serve as means of the tridimensional determination of an object in space. This purpose is either served by volumetric measurement or tridimensional calculation, i.e., as cranial capacity and as cranial and facial modules. For the measurements see table 9.

The cranial capacity ascertained with millet in the usual fashion, attains averages of 1554.2 cc. (1475–1675 cc.) in the males and 1200.0 cc. (1150–1300 cc.) in the females and therewith are, according to Sarasin's classification, aristencephalic in the former and euencephalic in the latter. It may be noted that all the male specimens range in the aristencephalic class, while of the three females two are oligencephalic and one is euencephalic. The pronounced gap between the male and female capacities, although signifying, and especially in the American Indian, well-known physical conditions of difference in favor of the males, may in the present case be laid to the small number of female crania.

The cranial module representing the mean of the three principal diameters of the skull, repeats the conspicuous sex differences revealed in the cranial capacities. The male and female averages yield 154.6 mm. (149.3–158.0 mm.) and 142.4 mm. (137.0–147.3) respectively.

Of the facial modules [12] the first one which engages the total (nasomental) facial height, attains averages of 123.7 mm. (117.0–132.7 mm.) in the males and 115.7 mm. (113.7 mm. and 117.7 mm.) in the females and accounts thus for the typical sex differences. The employment in the facial module of the upper (nasoalveolar) facial height seems to

TABLE 9

Cranial size: Capacity, cranial and facial modules.

MEASUREMENT	MALE			FEMALE		
	Cases	Range	Average	Cases	Range	Average
Capacity	6 [1]	1475–1675	1554.2	3	1150–1300	1200.0
Modules						
Cranial	7	149.3–158.0	154.6	3	137.0–147.3	142.4
Facial						
I [2]	6	117.0–132.7	123.7	2	113.7; 117.7	115.7
II	6	102.0–115.3	107.6	3	99.7–103.3	101.4

[1] The cranial capacity of the anomalous skull Glacier Island II ♀ juv-ad, accounted for in the preceding chapter, has not been joined with that of the other specimens of the table; it attained the high figure of 1725 ccm. in that singular case.

[2] Facial modules listed here as I and II differ by one measurement, namely, the facial height which is the total one (nasion–gnathion) in I and the upper height (nasion–prosthion [pri]) in II, according to the formula $\frac{L + Br + H \text{ (total or upper)}}{3}$.

the writer a matter of advisable and ready feasibility and of important comparative value for the reasons of very variable conditions in connection with the wear and loss of teeth, as also of the absence of the lower jaw as of frequent occurrence in any series of skulls. The averages here amount to 107.6 mm. (102.0–115.3 mm.) in the males and to 101.4 mm. (99.7–103.3 mm.) in the females.

As in most of the other cranial measurements and as also mentioned in connection with the cranial capacity, the female measurements range below those of the males in expression of typical sex differences. This holds true even for the relatively small numbers of the present series.

CRANIAL TYPOLOGY

The present series of skulls was subjected to an exhaustive examination with a view toward the recognition and establishment of cranial

[12] See measurements and footnotes in table 9.

types to be evidenced both descriptively and metrically. To the three skulls selected as cranial types and pictured in plates 1–5, the remaining specimens appear morphologically more or less closely and distinctly related. The three type crania come from Palutat Cave and are marked *B*2, *C*1 and *C*2, all of them male, although the sex of *C*2 seems doubtful. The metrical data may be found assembled in table 10.

The dominating feature in norma frontalis is the bizygomatic extension and the shaping of the zygomatic bone which is extremely crude and large in *C*1, where also the zygomatic processes of the maxillae are strongly developed. These conditions are markedly mitigated in *B*2 and *C*2, where the infrazygomatic crests show also shallower incurvations (see also fig. 7), a condition closely dependent on the height of the alveolar process, which is lowest in *C*1. Fossae caninae are almost absent in *B*2 and *C*2, and only mildly indicated in *C*1. From table 10 it will be seen that in its bizygomatic breadth *C*1 with 156 mm. exceeds the two other specimens at 132 mm. and 140 mm. respectively. The upper facial height with 84 mm. is greatest in the *C*1 specimen against the decidedly smaller measurements of 74 mm. in *C*2 and 76 mm. in *B*2. The upper facial index is mesenic with 53.9 and 54.3 in *C*1 and *B*2, but leptenic with 56.1 in *C*2 which, as also shown possesses the smallest bizygomatic breadth. The forehead complex is massive in *C*1 in contrast to the more elegantly shaped foreheads of *B*2 and *C*2. The contour in each case although least in *B*2, culminates into a midsagittal angular elevation illustrating the characteristic gable-roof or sagittal crest which generally has its maximum development in the postbregmatic region of the cranial roof. The characteristic measurements of the forehead complex are the projective height (n–b on E–E' plane) and the minimum frontal diameters, of which the former in the order *B*2, *C*1 and *C*2 attains 81 mm., 86 mm. and 91 mm., the latter 90 mm., 106 mm. and 95 mm. The mesial incurvation of the temporal lines of os frontale is quite pronounced in *B*2, less so in *C*2, while in *C*1 with the greatest minimum frontal breadth the temporal lines just above the zygomatic processes of the frontal bone follow rather straight and parallel courses.

The supraorbital eminences are most strongly developed in *B*2 and *C*1 and may be characterized as supramedium. Rather weak in *C*2 they add to the uncertainty in the sex diagnosis of this skull. Well-marked foramina supraorbitalia instead of incisurae are seen in *B*2 and *C*2 while *C*1 is distinguished by a right foramen and a left incisure.

The inferior facial complex in norma frontalis is particularly dominated by the chin height and the everted angles of the mandible. Both of these are conspicuous in *C*1, while the eversion is only mildly indi-

cated in $B2$ and $C2$, with a rather low chin in the former and a high one in the latter.

The orbital apertures are largest in $C1$, where the height and width measurements exceed those of the other two specimens without however producing more than a mesoconchic index (maxillofrontale) of 80.4 in contrast to the hypsiconchic indices of 87.2 in $B2$ and 87.8 in $C2$. With the lacrimale widths involved the orbital indices are hypsiconchic in each of the three specimens. Quite characteristic is the roundness of the inferolateral orbital angle which as such has been recognized as a Mongolian feature. The interorbital breadth (maxillofrontale) with 19 mm. in each of the cases reflects the average condition of the series. The biorbital breadth on the other hand brings out distinct differences which obtain with 97 mm. and 99 mm. in $C2$ and $B2$ and with 107 mm. in $C1$ and which raise the interorbital indices in the former two to 19.6 and 19.2 as against the same index of only 17.8 in $C1$.

The nasal aperture is, with indices of 37.5 and 40.7, pronouncedly leptorrhine in $B2$ and $C1$. $C2$ with a nasal index of 50.0 is mesorrhine as resulting from a comparatively lower height and greater width.

In norma lateralis the characteristics of the three skulls under investigation are demonstrated in the superposed midsagittal outlines of figure 11. These are individually oriented on their ear–eye planes (E–E') and more coincidingly on the nasion parallels (e–e') to the ear–eye planes. But although the outlines coincide in those nasion parallels they are superposed in such a way so as not to obstruct each other in the nasion region while also in the other sections of the craniograms confusion of lines has been avoided without however thwarting the purpose of showing the differences of type as revealed in the superposition. Table 10 will serve as a metrical basis in the following morphological diagnosis.

It will be noticed in figure 11 that the solid outline of $C1$ is distinguished by its evenly rounded occiput in expression of the general bulkiness of the specimen and which is furthermore demonstrated in the marked postbregmatic elevation of 6 mm. This latter feature does not show so distinctly in the superposition because of the individual ear–eye orientation of the crania. The other extreme of occipital bulging is that of $B2$ with its protruding occiput and occipital flexure already referred to (p. 69). Its cranial vault at the same time is quite depressed and the lowest of the three superposed specimens as may be judged by the auricular height of 108 mm. in contrast to 118 mm. in $C2$ and 120 mm. in the $C1$ skull. Approximating the latter skull in the occipital roundness of curve and auricular height is seen the third of the superposed

craniograms, that of $C2$. Quite interesting in this connection is the infraporial height extension of the three specimens which if proportioned to the auricular height diameters is, as may be gained from table 10, smallest in the highest skull ($C1$), larger by 6 mm. in the lowest ($B2$) and largest with 25 mm. in the intermediary curve ($C2$).

The ear–bregma heights as will be seen in tables 10 and 11 do not follow the same order of increase as noticed in the basion–bregma heights due to differentiation in infraporial extension. The length-height

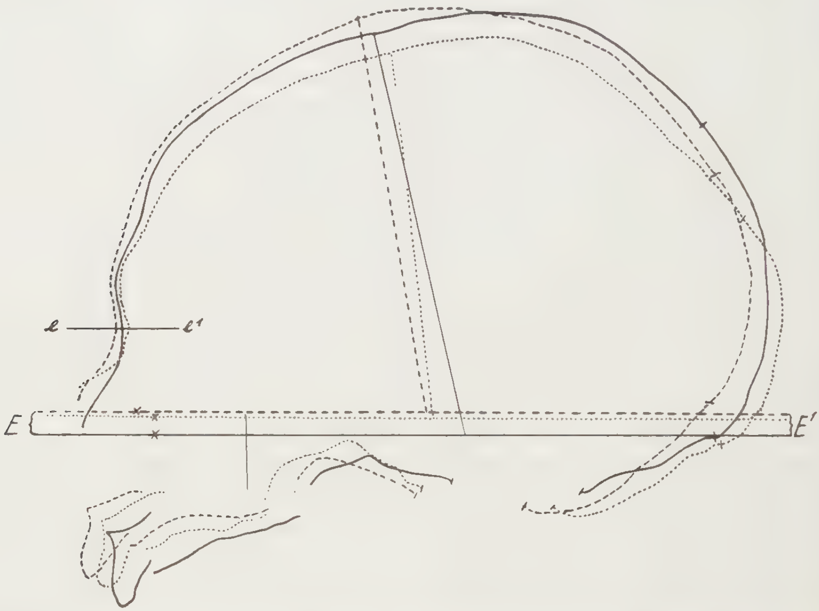


Fig. 11 Superposition of mediansagittal cranial outlines in individual ear–eye orientation (E–E'), coinciding on parallel to the latter (e–e') through nasion. – ———, Palutat Cave C1, ♂ mat; – – –, Palutat Cave C2, ♂? ad, and . . ., Palutat Cave B2, ♂ mat.

indices, however, the customary ones and the height indices after Hrdlička (p. 79), show the same order of proportion in $C1$ and $C2$, but not in $B2$ with the lowest length-height index of 66.2 and the intermediary height index (Hrdlička) of 76.1. The writer was tempted to apply Hrdlička's formula which mitigates the disproportions caused by the variable cranial lengths, also to the auricular heights with the following result (see table 11, last line): The height indices involving the auricular heights appear to be somewhat more concentrated than those employing the total basion–bregma heights, but do not follow the

TABLE 10

Measurements in cranial typology.

MEASUREMENT	PALUTAT CAVE *C*1 ♂	PALUTAT CAVE *C*2 ♂(?)	PALUTAT CAVE *B*2 ♂
Cranial			
Length	190	185	192
Breadth			
Cranial	148	137	142
Min. frontal	106	95	90
Height			
Basion–bregma	133	141	127
Basion–vertex	137	144	130
Auricular	120	118	108
Infraporial	14	25	20
Postbregmatic	6	3	4
Frontal (projective *n–b on e–e'*)	86	91	81
Facial			
Breadth	156	132	140
Height (upper)	84	74	76
Orbital			
Width (max. front.)	46	41	39
Width (lacrimale)	41	37	36
Height	37	36	34
Breadth			
Interorbital (*mf*)	19	19	19
Biorbital	107	97	99
Nasal			
Width	24	26	21
Height	59	52	56
Maxilloalveolar			
Length	58	55	56
Breadth	70	66	66
Mandible			
Ramus breadth	43	37	41
Ramus height	62	53	71
Chin height	41	33	40
Angles (ear–eye plane)			
Frontal	49	51	46
Interoccipital	102	122	117
Foramen magnum	— 4	— 4	— 10
Prognathy			
Facial	88	82	83
Midfacial	89	84	84
Alveolar	81	78	78
Ramus inclination	73	67	84
Indices			
Cranial			
Length–breadth	77.9	74.1	74.0
Length–height	70.0	76.2	66.2
Height (Hrdlička)	73.7	87.6	76.1
Breadth–height	89.9	102.9	89.4
Auricular height	63.2	63.8	56.3
Transverse			
Parietofrontal	71.7	69.3	63.4
Craniofacial	105.4	96.4	98.6
Facial (upper)	53.9	56.1	54.3
Orbital			
Maxillofrontale	80.4	87.8	87.2
Lacrimale	90.2	97.3	94.4
Interorbital	17.8	19.6	19.2
Nasal	40.7	50.0	37.5
Maxilloalveolar	120.7	120.0	117.9
Mandible			
Ramus	69.4	69.8	57.8

order of the absolute auricular height diameters. In this respect the length-height and the auricular height indices coincide in the order of increase which naturally is dependent upon the behavior of the two other metrical quantities involved.[13] According to the customary classification of the auricular height index *C*1 and *C*2 are slightly hypsicranial in contrast to the chamaecrany of *B*2.

The frontal region also expresses a variation in height and curve. The projective frontal height in ear–eye-nasion orientation differ among themselves by 5 mm. each, but do not sustain each other proportionally in relation to the auricular height, e.g., although the lowest auricular height of 108 mm. in *B*2 is prompted by the lowest frontal height of 81 mm., it is the intermediary auricular height of 118 mm. in *C*2 which possesses the greatest frontal height of 91 mm., while the greatest auricular height of 120 mm. in *C*1 associates itself with the intermediary frontal height of 86 mm. The elevation above the frontal chord, expressive of the height of the frontal curvation does not differ much in our three specimens. There is however a gradual height diminution from 24 mm. in *C*1, over 23 mm. in *C*2 to 22 mm. in *B*2 which latter already by visual estimation shows a somewhat flatter frontal outline.

The glabellar region in lateral projection is well marked in its bulky protrusion in *C*1 and *B*2, but less so in *C*2 as commensurate with the weaker supraorbital eminences.

The facial complex appears quite concentrated in *C*1 against the anteroinferiorly protruding alveolar processes in *C*2 and *B*2. Expres-

[13] Table 11.

TABLE 11

Comparative measurements of cranial heights.

MEASUREMENT	*C*1 ♂	*C*2 ♂ (?)	*B*2 ♂
Cranial length	190	185	192
Cranial breadth	148	137	142
Cranial height	133	141	127
Auricular height	120	118	108
Indices			
Length–height	70.0	76.2	66.2
Auricular L–H	63.2	63.8	56.3
Auricular height = $\dfrac{\text{Aur. H.} \times 100}{\dfrac{\text{L} + \text{B}}{2}}$	71.0	73.3	64.7

sive of these conditions are the angles of prognathism as shown in the superposed craniograms of figure 11 and table 10 and which tend to be entirely orthognathous in *C*1, but show a tendency toward prognathy in *C*2 and *B*2. Characteristic also is the extent of alveolar height referred to already in norma frontalis and which in conjunction with the alveolar protrusion renders the facial subcomplex quite slender in its general structure as observed in lateral projection. The nasal bridge possesses the Indian characteristic of more or less pronounced concavity, especially in *B*2, but least so in *C*1. It may be further observed that the temporal lines run higher upon the cranial walls in *C*1 than in *C*2; they are unfortunately obscured through scaling in *B*2. The forward bent, after its semicircular course, of linea temporalis inferior upon squama temporalis produces distinct supramastoid crests which seems to be an Eskimo-Indian characteristic and which is especially strongly developed in P. V. I ♂, a specimen not contained in the present chapter on cranial typology (see p. 73).

Our three specimens have medium-to-well developed mastoid processes.

In norma verticalis it is the cranial contour, the postorbital constriction and in connection with the latter the behavior of the zygomatic arches which dominate the picture. The contours according to G. Sergi's scheme are ovoid in *B*2, pentagonoid in *C*1 and *C*2. Postorbital constriction measured in terms of minimum frontal breadth differs considerably yielding the maximum of 106 mm. to *C*1, the bulkiest of our specimens, and then leaving a wide hiatus between this and the other two crania with 95 mm. and 90 mm., the latter belonging to *B*2. Phaenozygy is decisively expressed in all three specimens, most pronounced indeed in *C*1 and resulting there from the comparatively large facial breadth of 156 mm. in contrast to 132 mm. and 140 mm. in the *C*2 and *B*2 crania.

The cranial length-breadth and transverse parietofrontal indices are best adapted metrically to interpret typological differences in this norma. The former indices are seen to express mesocranial conditions quite decidedly when *C*1 falls comfortably into the mesocranial division of the index, while *C*2 as well as *B*2 hover slightly below but almost coincide with the line of demarcation between dolicho- and mesocrany. Quite expressive on the other hand are the transverse parietofrontal indices which render *C*1 and *C*2 eurymetopic in various degrees and *B*2 pronouncedly stenometopic, commensurate with the metrical differences in minimum frontal breadth.

The morphological aspect in norma basilaris corroborates the impression of general structural conditions where $C1$ represents robustness and bulkiness emphasized furthermore by the greater cranial breadth which tends to mitigate the effectiveness of pronounced cranial length, and the massiveness of the zygomatic arches referred to in various places. All this appears mitigated in $C2$ and $B2$ to an extent where the latter specimen occupies an intermediary position between $C1$ and $C2$. Of configurative importance in the basilar aspect appears also the maxillopalatal complex with its strikingly narrow impression particularly in $C2$ against the more dilatory conditions in $C1$. In addition to the metrical data of tables 10 and 11, the list of measurements on table 12 which shows the maxillocranial proportions, is of interpretative significance.

TABLE 12

Maxillocranial measurements.

SPECIMEN	CRANIAL		MAXILLOALVEOLAR		CRANIOMAXILLARY INDICES	
	Length 1	Breadth 2	Length 3	Breadth 4	Length $\frac{3 \times 100}{1}$	Breadth $\frac{4 \times 100}{2}$
P. C. (B2)♂	192	142	56	66	29.2	46.5
P. C. (C1)♂	190	148	58	70	30.5	47.3
P. C. (C2)♂?	185	137	55	66	29.7	48.2

The gradual diminution, although small, in the craniomaxillary length index is quite significant but still more so the figures of the breadth index where the smallest cranial breadth gives rise to the highest index of 48.2 in $C2$, the greatest attaining only an intermediary position of 47.3 in $C1$, while the relatively small index of 46.5 in $B2$ is due to the intermediary cranial breadth in proportion to a maxilloalveolar breadth which coincides with that of $C2$.

In norma occipitalis the outstanding feature is the cranial contour which in each case represents the so-called "house shape". The contours vary among themselves to the extent that in $C1$ the gable, although in this norma distinctly marked in the ridge of the roof, is somewhat broader and flatter in its sides than those of $C2$ which are steeper and narrower while its roof ridge is slightly rounded in the posterior aspect. Consulting the metrical data of table 10, it will be found that $C2$ is considerably narrower and at the same time higher than $C1$ which is also expressed in the breadth-height indices and which are with 89.9

tapeinocranial in *C*1 and with 102.9 acrocranial in *C*2. In *B*2 the contour as well as the metrical proportions resemble those of *C*1, although in its absolute diameters *B*2 is considerably smaller and its contour in toto appears somewhat more roundish. The breadth-height index of *B*2 at 89.4 fairly coincides with that of *C*1 at 89.9. The transverse base line in occipital projection is in the three specimens almost straight, divided however by crista occipitalis externa into two downward slightly convex halves. The mastoid processes of only medium development in *C*2 and *B*2 are weakly showing in these two specimens but are seen to somewhat better advantage in *C*1.

The mandibles belonging to the three type crania under discussion share in a general way the latters' general habitus, i.e., they are comparatively large and robust in *B*2 and particularly in *C*1. *C*2 is more elegant in appearance, its dental arch, in conformity with that of the upper jaw in the same specimen (see p. 82) showing rather straight sides which furthermore are angularly set off in the canines against the straight line of the incisor teeth. Muscle marks are strongly developed in the former two, but contrastingly more mildly expressed in *C*2.

An interesting morphological feature is shown in the anterior basilateral region of the *B*2 mandible where a strong longitudinal bulge extends from tuberculum mentale posterius (Klaatsch, '09, p. 112; see p. 57) to about the region below the second molar. This bulge occurs symmetrically on both sides and along its upper margin and below foramen mentale causes a deep longitudinal groove which is Klaatsch's ('09, p. 112) sulcus supramarginalis s. mentalis or H. Virchow's sulcus platysmaticus, or Weidenreich's sulcus intertoralis (see p. 84). The chin, through this formation, becomes quite prominent and the basal margin widened anteroposteriorly so that the digastricus insertions occupy rather deep positions not unlike similar conditions in the anthropoids.

The mandibular outlines of the three mandibles under discussion are superposed in figure 12 and readily display their morphological habitus as described above. The slight excess in the height of processus muscularis over processus articularis in *C*1 and *C*2 in connection with the deep incisurae mandibulae show Mongoloid affinities according to Puccioni's ('14, p. 310) diagnosis. The condylocoronoid height relations differ slightly in *B*2, but incisura mandibulae is also well developed.

Attention may also be called to the posterior ramus slant as expressed by the ramus angle between the posterior ramus tangent and the alveolar plane line and which attains only 67° in the *C*2 specimen in contrast to 73° and 84° in *C*1 and *B*2. The small angle of *C*2, rather

a female mark, adds another item of doubt in regard to the real sex of this specimen referred to on p. 76.

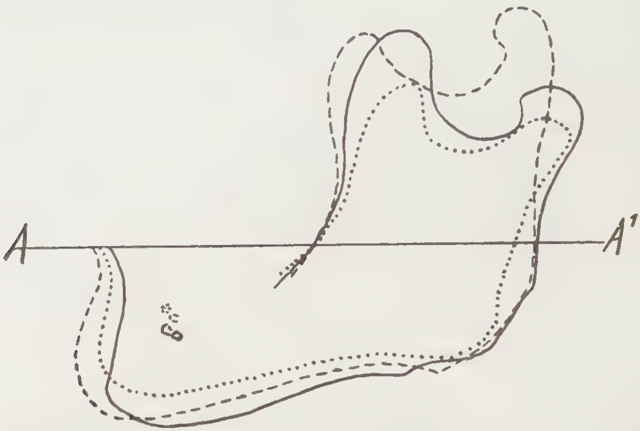


Fig. 12 Superposition of mandibular outlines in lateral projection, oriented on A–A' alveolar plane line, the postmolar points coinciding. – ———, Palutat Cave C1 ♂; – – –, Palutat Cave B2 ♂; . . ., Palutat Cave C2 ♂?.

COMPARATIVE MORPHOLOGY

For a comparative evaluation of the morphometric status of the present crania, a number of more or less closely related groups have been drawn upon for representative metrical data. The ethnic groups, as shown in table 13, are: Alaska Eskimo; East Greenland Eskimo; Haida Indians from the Queen Charlotte Islands; Indians from San Miguel Island, California; Siberians from Indian Point, East Cape, Siberia, and Landak-Dayaks from Borneo (Hoessli, '16; Hrdlička, '30; Oetteking, '30; Yokoh, '40). The measurements assembled in table 13 concern (1) the cranial and facial modules, the latter with the upper instead of the total height; (2) the following indices: cranial L–Br; L–H; mean height (Hrdlička, see p. 79); Br–H; upper facial; orbital (maxillofrontale and lacrimale); nasal; maxilloalveolar; gnathic; ramus, and (3) the ramus angle.

The figures for the cranial module, with male average values above 150 mm. and reaching its maximum of 156.2 mm. in the East Greenland Eskimo, reveal a fair uniformity between the Eastern and Western Eskimo inclusive of the Siberians as against the Indians of San Miguel Island with only 148.0 mm. Ranging quite high, the males of the present series yield an average cranial module of 154.6 mm. while proportionately the females reflect more or less precisely the metrical conditions

GROUP	MODULES		INDICES									MANDIBLE	
	Cranial	Facial (upper)	Cr. L–Br	Cr. L–H	Cr. Mean H (Hrdlička)	Cr. Br–H	Upper fac.	Orb. (mf)	Nasal	Maxilloalv.	Gnath. (flower)	Ramus ind.	Ramus angle
MALES													
Prince William Sound Present Series	(7) 154.6	(6) 107.6	(7)77.3	(7)73.4	(7)82.2	(7) 95.4	(6)55.5	(7) 83.6 (92.6)[2]	(7)43.0	(7)123.5	(7) 99.7	(9)60.5	(10)74.2
Eskimo, Alaska (Oetteking, '30)	(33) 152.3	(33) 105.5	(33)77.0	(32)74.2	(32)83.8	(32) 96.5	(32)55.7	(33) 83.3 (91.8)	(32)44.2	(22)123.5	(33) 98.3	(1)63.9	(1)66.0
Haida, Queen Charlotte Islands (do)	(18) 155.0	(16) 106.9	(18)77.8	(18)74.6	(18)83.8	(18) 95.9	(16)52.5	(16) 78.9 (86.4)	(16)51.5	(16)120.3	(16)100.0	(14)61.0	(14)70.3
Eskimo, East Greenland (Hoessli, '16)	(17–18)[1]156.2	(13–16)[1]107.6	(18)69.9	(17)73.6	(18)86.8	(17)105.4	(13)54.2	(16) 78.5 ( )	(16)43.1	(15)134.6	(16) 96.4	(21)69.2	
Indians, San Miguel Island, Cal. (Mus. Am. Ind., Heye Found.)	(67) 148.0	(63) 100.2	(68)78.9	(67)72.9	(68)81.9	(67) 92.3	(64)51.9	(68) 82.0 (90.2)	(68)47.1	(63)118.1	(64) 99.5		
Siberians, Indian Point, East Cape, Siberia (Hrdlička, '30)	(13) 155.4	(8) 108.3	(14)77.0	(13)73.6	(13)83.0	(13) 95.2	(10)55.7	(14)(92.7)	(14)45.7	(8)119.6	(8) 99.2		
Landak-Dayaks, Borneo (Yokoh, '40)	(11) 150.3	(9) 99.1	(11)77.9	(10)78.[illegible]	(11)87.9	(10)101.3	(8)49.4	(12) 83.6	(10)55.3	(7)120.6	(8) 96.1	. .	. . .
FEMALES													
Prince William Sound Present Series	(3) 142.4	(3) 101.1	(4)79.4	(3)74.5	(3)83 2	(3) 94.1	(3)54.0	(4) 85.5 (95.5)[2]	(3)46.9	(3)121.1	(3)103.8	(7)62.4	(4)69.5
Eskimo, Alaska (Oetteking, '30)	(12) 146.8	(12) 100.4	(12)79.0	(11)76.6	(12)85.2	(11) 96.7	(12)55.5	(12) 85.1 (92.3)	(12)46.0	(9)121.4	(11) 99.5		.
Haida, Queen Charlotte Islands, (do)	(8) 149.4	(8) 101.9	(8)83.0	(8)77.6	(8)84.8	(8) 95.7	(8)54.0	(8) 84.1 (91.1)	(8)50.9	(8)120.6	(8)100.8	(6)61.0	(6)64.3
Eskimo, East Greenland (Hoessli, '16)	(10–11)[1]146.0	(8) 98.3	(9)72.0	(8)76.6	(8)89.1	(10)106.5	(8)53.4	(9) 87.8 ( )	(8)44.7	(7)117.7	(8–9) 98.0	(10)72.8	.
Indians, San Miguel Island, Cal. (Mus. Am. Ind., Heye Found.)	(15) 142.1	(15) 95.6	(15)79.4	(15)71.8	(15)80.1	(15) 90.6	(15)53.4	(15) 84.9 (93.5)	(15)46.2	(14)118.7	(15) 99.4		. . . . .
Siberians, Indian Point, East Cape, Siberia (Hrdlička, '40)	(16) 148.8	(13) 103.0	(16)77.9	(16)76.2	(16)84.5	(16) 96.4	(12)55.0	(15) 91.9	(15)47.4	(4)123.0	(13)101.7		.
Landak-Dayaks, Borneo (Yokoh, '40)	(9) 142.1	(5) 95.5	(9)79.8	(9)76.7	(10)88.8	(9) 98.5	(4)53.3	(8) 86.9	(7)56.5	(4)111.5	(4)105.9	. . .	

[1] The double figures in the frequency columns of this group signify that their modules were computed by the present writer from the averages of the factors involved, and which varied as to the number of individuals from whom the averages were derived.

[2] The parenthesized figures in the male and female columns of the orbital index account for this index with the lacrimale instead of maxillofrontale widths.

of the males. The female averages of the Eskimo groups fall into the numerical domain between 142–148 mm. inclusive of the Indian and Dayak figures of 142.1 mm. each. The proportional differences between the male and female cranial modules vary between 5.5 mm. in the Alaska Eskimo to 12.2 mm. in our series, reaching as high a difference as 10.2 mm. also in the Greenland Eskimo and of 8.2 mm. in the Dayaks. It will be noted that a small sex difference of only 5.6 mm. and 5.9 mm. likewise obtains in the Haida and the Indians of San Miguel Island.

The facial module reiterates more or less precisely the metrical proportions of the cranial module. While in the Eskimo groups the males run from 105.5 mm. in the Alaska to 108.3 mm. in the Siberian Eskimo including our own male average of 107.6 mm., the San Miguel average comes to only 100.2 mm. and is met there by the Dayak males with 99.1 mm. The Haida with 106.9 mm. range quite high and fall in line with the Eskimo. The female figures of the San Miguel Indians and the Dayak attain the lowest averages of 95.6 mm. and 95.5 mm. in contrast to the remaining Western Eskimo groups which range from 100.4–103.0 mm. including the average of 101.1 mm. of the females of the present series and of 101.9 mm. of the Haida. The East Greenland Eskimo, peculiarly enough, come to a female average of only 98.3 mm. The proportional differences between the male and female averages are naturally smaller than those for the cranial modules, they range from 5.1 mm. in the Alaska Eskimo to 9.3 mm. in the Greenland Eskimo, leaving a proportional difference of 6.5 mm. to the Prince William Sound crania, and only of 4.6 mm., the lowest altogether, to the San Miguel Indians, while the still lower average of 3.6 mm. goes to the Dayaks.

The cranial length-breadth index shows the Eskimo-Indian groups, including the Dayaks, outspokenly mesocranial with male index averages around 77, except the East Greenland Eskimo whose typical status is characterized by a male dolichocranial average of 69.9. Typically higher averages around 79 are attained by the females with a tendency toward brachycrany, but a true brachycranial average occurs in the Haida, namely, 83.0. The tendency toward brachycrany is less pronounced in the Siberians at 77.9 and more coordinated there with the male status, and naturally in the East Greenland Eskimo with a female average of 72.0 which is somewhat less dolichocranial than that of the males. The female average of the Dayaks with 79.8 conforms to that of the Western Eskimo.

In the cranial length-height index the males of all the groups of table 13, except the Dayaks at 78.3, are peculiarly uniform with orthocranial

averages around 73, the lowest of them however falling to the San Miguel Indians with an average value of 72.9. The females, except the San Miguel Island Indians at 71.8, exceed the males with hypsicranial averages of 76 and, with additional fractions, the Alaska and East Greenland Eskimo, the Siberians and the Haida. In the Dayaks, although both sexes are hypsicranial, the female average falls below the male. The female average of our Prince William Sound crania with 74.5 exceeds but slightly the male average of 73.4. It remains orthocranial like the male average which is also the case in the San Miguel Islanders where however the female average of 71.8, the lowest of the list, falls slightly below the male average of 72.9.

A more differentiated appraisal of the proportions involving the cranial height is doubtless reached by Hrdlička's cranial mean height index. In a general way however it reflects the proportional status as already expressed by the cranial length-height index even by preserving the comparatively low index position of the San Miguel Islanders and by ranging the latters' female average below that of the males, i.e., 80.1 below 81.9. The sex proportion of the averages of the length-height index of the Dayaks is in the cranial mean height index reversed to the typical condition of the female average exceeding the male.

The relative height of the skull is more reliably adjudged by the cranial breadth-height index than by the length-height index, for the reason that of the factors involved in those proportions the cranial breadth is less variable than the cranial length. Their disproportional behavior has led Hrdlička to introduce his "cranial mean height index", discussed in the preceding paragraph. On that presumption then there are in comparison to the more unified averages of the Western Eskimo and Siberians two striking exceptions to be noted as occurring in the East Greenland Eskimo and the San Miguel Island Indians. While thus the Western Eskimo and Siberians, including our Prince William Sound crania and the Haida vary around metriocranial index averages of 95, the East Greenlanders rise to pronounced acrocrany with 105.4 in the males and 106.5 in the females, in contrast to tapeinocranial San Miguel Indian averages of 92.3 (upper limit of tapeinocrany) in the males and 90.6 in the females. The Dayaks, peculiarly enough, also attain acrocranial averages with 101.3 and 98.5 in the sexes. It will easily be recognized that in comparison with the length-height index, and as stated above, the average figures of the breadth-height index are more differentiated than those of the former index.

The general morphology of the skeletal face without the lower jaw, and signified by the upper facial index, is characterized by a leptenic

(high upper face) tendency in the Eskimo and Siberian groups of table 13, including the Prince William Sound crania with male and female averages of 55.5 (lower limit of lepteny) and 54.0 (upper limit of meseny), and despite some remarkably broad faces like that P. C., C1 ♂ with bizygomatic breadth of 155 mm., but an individual index which falls mesenic. A very slight relapse from the general morphological status will be noticed in the East Greenlanders with male and female averages of 54.2 and 53.4, both mesenic in the higher stations of this index group. A noteworthy exception from the general status is afforded by the San Miguel Islanders where the males with an average of 51.9 cling closely to the borderline between euryeny and meseny while the females with an average of 53.4 hold a slightly higher position in the mesenic group due quite probably to their fewer numbers, i.e., 64 against 15. Close to these lie the Haida Indians with mesenic averages of 52.5 and 54.0 in the sexes. The Dayak males fall still lower with a euryenic average of 49.4, while the females of this group with 53.2 are mesenic like most of the other groups.

The orbital index with both the maxillofrontale and lacrimale widths signifies somewhat high orbits in the sexes, but typically with the higher orbits in the females. All the male averages then except the Siberians whose maxillofrontale widths have not been recorded, fall into the mesoconchial division of the index, exceeded, however, and in corroboration with the above statement, by, in most cases, the hypsiconchial females. This proportion obtains also in the Dayaks. Quite remarkable in this respect is the sex difference in the East Greenland Eskimo where the males yield a rather low mesoconchial average of 78.5 and the females a decisive hypsiconchial average of 87.8. Somewhat similar fall the Haida averages with 78.5 and 84.1 in the sexes. The San Miguel Islanders fall completely into the mesoconchial division, marking the upper limit with a female average of 84.9, while the male average with 82.0 somewhat approximates that of the females. With the lacrimale widths all the index averages are hypsiconchial with figures above 90.

The general morphometric status of apertura piriformis is leptorrhinic by the averages of the nasal index. The typical sex differences of a wider female nasal aperture obtains also among the groups under discussion to the extent that the female averages with values of 46 and fractions mark the very border between leptorrhiny and mesorrhiny. It is quite interesting to note that in the Greenland Eskimo who are known for their narrow noses, the female average of 44.7 also completely conforms to this morphological condition. It will also be noted

that as indicated by their male and female averages of 45.7 and 47.4, the Siberians are slightly broader-nosed than the American Eskimo groups. Their averages resemble those of the San Miguel Islanders where however the male average of 47.1 slightly exceeds that of the females at 46.2 thus rendering the former mildly mesenic. Chamaerrhiny in a slight degree obtains in the Haida males at 51.5 against a marked female leptorrhinic average of 44.7, while in the Dayak both male and female averages of 55.3 and 56.5 are decidedly chamaerrhinic.

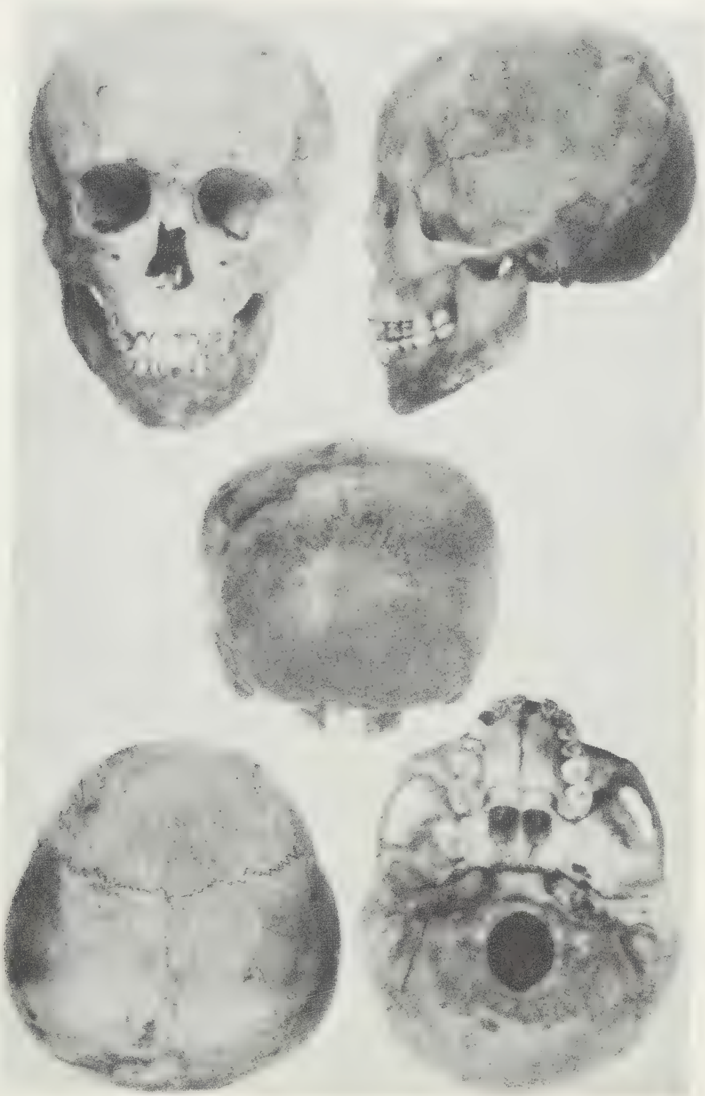
The averages of maxilloalveolar index are brachyuranic throughout and with the females ranging below the males in the crania from Prince William Sound and of Alaska and East Greenland Eskimo as well as in the Dayaks where the females with an average of 111.5, however, are mesuranic. This sex proportion is reversed in the Siberians with averages of 119.6 and 123.0 in the sexes, due also here quite probably to the smaller number of female crania. The averages furthermore in the San Miguel Islanders are alike in the sexes at 118.1 and 118.7, while at the same time their male index represents the lowest, their female index the second lowest averages in their respective columns. Equality of index averages at 120.2 male and 120.6 female prevails also in the Haida. Although brachyuranic in their general proportions, the different stages occupied by the male and female averages in the brachyuranic division of the index illustrate also here the physical sex differences.

Prognathism, if judged by the gnathic index, is seen to be more pronounced in the females of the various groups of table 13 in illustration of the usual sex difference. Exceptionally low, i.e., orthognathous averages are those of the East Greenlanders where the males attain 96.4, the females 98.0 and marking therewith the line of separation between ortho- and mesognathy. There is furthermore, with slightly mesognathous averages of 99.5 and 99.4, an equality between the sexes of the San Miguel Island Indians. All the other averages show advanced stages of mesognathy, our Prince William Sound females with an average of 103.8 even entering the prognathous division of the index, while the Siberian females with 101.7 mark a high station in mesognathy. The Dayaks with an average of 96.1 are orthognathous in the males, in contrast to their decidedly prognathous females with 105.9. An equality of slightly advanced mesognathy at 100.0 and 100.8 in the sexes obtains in the Haida.

The few comparative figures available for the mandible, namely, the ramus index and ramus angle disclose what has previously been discussed on their behalf. Greater slenderness of the female ramus is

rather typical in the racial groups. Furthermore, the few available data demonstrate, in addition to the usual sex divergences, a marked difference between our Prince William Sound mandibles with male and female index averages of 60.5 and 62.4 and those of the East Greenlanders at 69.2 and 72.8, signifying more massive morphological conditions in the latter. The Haida averages, equal again at 61.0, fall close to those of the present series. The typically greater extent of ramus inclination in the females is revealed by the ramus angle of our mandibles with 74.2° for the males and 69.5° for the females, a condition corroborated by the Haida data of 70.3° and 64.3° in the sexes.

(To be concluded)



Pathological skull from Glacier Island, Alaska,
II ♀ juv-ad, in its five normae.

REVIEWS

WOMEN AND MEN. By Amram Scheinfeld. Harcourt, Brace and Company, New York. xv + 453 pp., 13 tables, 41 illustrations, bibliography, 1944. ($3.50)

There is a lamentable, but unavoidable, lag between the acquisition of new knowledge in any field and the time when it comes effectively to the attention of all those who are in a position to utilize it. This is especially true of problems to the solution of which contributions are made by workers in various sciences, each of whom tends to publish his findings in journals devoted to his own specialty. Critical reviews which summarize all pertinent published reports are especially needed in such instances, but workers are reluctant to undertake them, because they do not wish to attempt an appraisal of findings from fields in which they have no special competence. The lack, until Mr. Scheinfeld's book appeared, of any similarly comprehensive attempt to bring together from many fields the existing information about sexual differences in man has deprived many who are interested in the subject of a more adequate idea of what those differences are and of a fuller understanding of the factors which are responsible for them.

In the introduction to his book, the author acknowledges his indebtedness to a long list of specialists whom he consulted during the preparation of his manuscript. The fact that he profited from their counsel does not detract from the credit due him for the laborious study and the critical evaluation of the literature on which his book is based. A selected bibliography of some twenty-seven pages of titles, practically all of which are referred to in the text, attests to the thoroughness with which the author has familiarized himself with his material.

After a brief introductory chapter, the author begins his discussion of human sexual differences. He starts with a simple, non-technical description of fertilization and of the influence of the sex chromosomes in sex determination. In subsequent chapters he traces the emergence of physical and other differences in boys and girls as they increase in age. Considerable space is devoted to a consideration of changes which occur in infancy, in early childhood, and especially to those manifesting themselves at puberty and during adolescence. The later chapters are devoted to differences between men and women and to a discussion of the relative importance of heredity and environment in their causation.

"Women and Men" is written primarily for the intelligent layman. The author has been quite successful in reducing the use of technical terms to a minimum and in giving adequate definitions and explanation of those which he found it necessary to employ. He writes clearly and well, and his style is calculated to gain and to hold the reader's attention. If some of our scientific colleagues find his style a bit too racy in places, let them remember that the book was not addressed to them — though, if they learn nothing from reading it, they must have an unusually good knowledge of the subject. Let them observe, further, that it is quite free from any taint of that pompous condescension which so often mars the attempts by scientists to write about their technical fields in terms that are understandable to laymen.

There are those among us, especially in university work, who, in one breath, lament the layman's lack of interest in scientific matters and in the next, urge the academic ostracism of any of their colleagues who attempt to create such an interest by writing "popular" articles or books on scientific subjects. This is a most short-sighted attitude and one which is to a large extent responsible for the very lack of interest and understanding which they profess to deplore.

What Mr. Scheinfeld has accomplished in this book and in a previous volume, "You and Your Heredity," represents a most effective type of adult education in two areas in which the great majority of laymen are much in need of dependable information. In writing them, the author has, in the opinion of the reviewer, rendered a valuable service to scientists as well as to those for whom the books are primarily intended.

William Walter Greulich
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TEMPO AND MODE IN EVOLUTION. By George Gaylord Simpson. Columbia University Press, New York City, 1944. 217 pp. of text, bibliography, and index. 36 figures, 19 tables. Price $3.50.

The basic problems of evolution, as Dr. Simpson points out in the introduction to his present work, are too extensive, too fraught with difficulty, to be solved or even approached successfully from the standpoint of any one biological discipline. These remarks take on a peculiar pertinence when expressed by a paleontologist of Dr. Simpson's caliber, and they come opportunely. Geneticists have been particularly vocal of late in the expression of their views on evolutionary subjects. The paleontologist who, by reason of the great range of time open to his examination is in a markedly advantageous position to contribute his share toward the solution of many biological problems, has remained, for the most part, occupied with the descriptive phases of his subject. His silence has, in some quarters, been taken as evidence that his task is done and that he has nothing further to contribute. Dr. Simpson's book should cause the holders of such opinions to revise their views.

As its title indicates, the volume is concerned with rates of evolutionary change, with the problems of micro- and macro-evolution, with inertia, trends, orthogenesis, and similar questions which perennially beset the scientist. Specific studies and specific evolutionary sequences are used only as they illustrate points under discussion. The value of the work to the physical anthropologist lies in its treatment of problems which are just as important to the student of the Hominidae as to those from other biological disciplines. The anthropologist must read, think, select, and interpret in terms of his own problems.

Simpson adduces evidence, for example, to show that Henricosbornia lophiodonta, an extinct notoungulate mammal, was an amazingly variant creature. A population from a single locality showed "extraordinary structural variability." Such paleontological cases should force us to give due consideration to the fact that McCown and Keith's theories about the Skhul people are not entirely indefensible. The reviewer would like to make it clear that, although he feels the

Mount Carmel material is better explained, in our present state of knowledge, on the basis of hybridity, he does not believe the somewhat vigorous attacks launched upon the opposing viewpoint are wholly justified in the light of existing evidence. It is quite true that small rates of gene mutation over long time periods should not produce in a single population the effects noted among the Skhul folk. It is equally true, however, that no one has studied the evolution of mammalian forms over whole geological periods in the convenient perspective of a milk bottle. "It is," says Simpson, "a common paleontological observation that some groups of animals go through stages of relatively sudden diversity, sometimes intragroup . . . "

Simpson observes that characters undergoing degenerative change often show extreme variability in a given population. "This . . . . has probably become apparent to every paleontologist who has handled large collections." He notes striking dental variations in Hoplophoneus as an instance. In the light of such examples, why should we not expect great individual variation in such a degenerating character as the supra-orbital torus? Perhaps we have expecred too much of this character as a diagnostic aid in classifying scattered groups of late Pleistocene Neanderthals. This is only a suggestion, of course — and a single item — but it indicates that there is food for thought here upon many human problems.

In addition, Simpson devotes painstaking attention to the subject of large scale evolution. He says, in part: "The experimentalists and most neo-zoologists concentrate on discontinuities of the lowest order, a promising point of attack, but one that may produce a myopic outlook . . ." He thinks that certain major gaps in the phyletic record are only explainable by assuming that the animals involved in the transition were few in number and changing at a very fast pace, though without saltation. The rather common assumption that rates of evolution are more or less uniform is adequately treated and dismissed as contrary to the geological record.

To review a compact, highly concentrated work of this kind in a few paragraphs and yet give an adequate glimpse of its riches, is impossible. It is one of the most important paleontological publications of recent years. One can only reiterate that it is the mature product of a superlatively gifted mind, and that it deserves its place in the Columbia Biological Series, along with the distinguished contributions of Dobzhansky and Mayr.

Loren C. Eiseley
Oberlin College

THE FOETAL CIRCULATION. By Alfred E. Barclay, Kenneth J. Franklin and Marjorie M. L. Prichard. (From the Nuffield Institute for Medical Research, Oxford University.) Blackwell Scientific Publications, Ltd., Oxford. xvi + 275 pp., 162 text figures and 5 plates, bibliography, index, 1944. (50 shillings.)

A comprehensive survey of present knowledge concerning fetal circulation, structural peculiarities of the fetal cardiovascular system, and the functional and anatomic changes which occur at birth. The account is centered on the authors' extensive investigations, and it includes a thorough coverage of related lit-

erature. The publication stands as a significant milepost in the advance of knowledge relating to functional anatomy of the fetal circulation.

Teamwork in research and the application of productive technics are outstanding features of the authors' approach. The principal observations were made on living fetal lambs, after delivery by Caesarian section and with the fetal-maternal circulatory relationship maintained; the fetuses were kept under conditions approximating the intrauterine environment as closely as possible, and as desired these conditions were modified to simulate the changes which occur at birth. For tracing the blood stream a contrast medium (usually parabrodil) was injected intravenously and x-ray motion films were made as records. Sites of injection (umbilical vein, femoral vein, mesenteric vein, etc.) were varied in accord with the paths to be traced. The courses of blood, under conditions corresponding to those obtaining both before normal birth and after, are described in full detail. The precision of the records is noteworthy; they show, for example, the division of the stream from the placenta after its entrance into the right atrium — a larger volume entering the left atrium by way of the foramen ovale and the remainder passing to the right ventricle. An object lesson of broad interest is repeatedly demonstrated: various functional deductions drawn from dead material, for example in reference to degrees of competence of postnatal closure of the foramen ovale, are shown in the intact living animal to be erroneous.

Several new anatomical terms (e.g., via sinistra for foramen ovale) are proposed as being more fitting than names which have been in common use. The liver is treated, from the standpoint of the circulation through it, as being composed of two moieties, umbilical and portal. The fetal anatomy of heart, liver, lungs and pertinent vessels is described in a series of mammals, including man, the results being compared and interpreted with the lamb as a standard.

HAROLD CUMMINS,
Tulane University

DICE OF DESTINY: AN INTRODUCTION TO HUMAN HEREDITY AND RACIAL VARIATIONS. By DAVID C. RIFE. Long's College Book Company, Columbus, Ohio. 163 pp., 23 figures, bibliography, index, 1945. ($1.75)

The author of this provocative little volume is a geneticist whose investigations in human biology have been concerned mainly with twins, handedness and dermatoglyphics. A considerable share of the factual content of the text is drawn from his own studies. Designed for non-professional readers, the book aims especially to broaden understanding of the nature of racial differences and to point the way toward more satisfactory relationships among races and national groups. At the same time it serves another purpose as a primer of genetics.

Appearing frequently in the text, the catchword "dice of destiny" lends a familiar note to discussions of the factor of chance — here of course in relation to the production of an individual with specific traits. The elements of chance are random assortment of genes in maturation of the sex cells and fortuitous election of the involved sperm and egg.

Examples of inheritance are drawn entirely from normal variations. The first chapter introduces the reader to genetics by reference to "tasters" and "non-

tasters." The text includes a brief explanation of how the trait is determined in the individual and of the basis of variation among racial groups in the relative frequencies of tasters and non-tasters. The same general treatment is applied in discussions of blood groups, stature, cephalic index, finger prints, etc. There are informative chapters dealing with the genetics of sex, with twins, handedness, mental capacity, personality. A special chapter on race presents racial differences as a genetic parallel to the differences obtaining among breeds of domesticated animals. The concluding chapter, "Genes and Democracy," briefly outlines the author's philosophy on the social order. It is repeatedly emphasized throughout the book that the distinguishing characters of races are conditioned by the same principles of inheritance and environmental effect which are responsible for differences among individuals of one race.

HAROLD CUMMINS,
Tulane University

PHYSICAL GROWTH FROM BIRTH TO TWO YEARS: I. STATURE. By HOWARD V. MEREDITH. University of Iowa Studies, Studies in Child Welfare. Volume XIX, Number 407. University of Iowa Press, Iowa City, 1943, viii + 255 pp. and appendix containing 23 tables.

This volume attempts "to afford a comprehensive review and synthesis of one readily delimitable segment of the research literature on physical growth during infancy. Concisely, the segment treated encompasses the problems, procedures, and findings from investigations on infant stature made in North America prior to 1942." In the opinion of the reviewer, the author not only is well-qualified to undertake this task, but also has succeeded admirably in fulfilling its requirements. The organization of the materials, centered about the formulation of leading questions and a summary of accrued findings about these questions, is especially useful. The grouping of questions and findings are: overall view, secular differences, racial differences, geographic differences, socio-economic differences, differences with parity, age, and stature of mother, sex differences, differences among seriatim records for individual infants, stature of infants born prematurely, relationships between stature and disease, and stature in relation to diet indicate the scope of the work. The writing is simple and to the point. The interpretation is conservative and well-balanced throughout.

Part II (pp. 115–237) is an annotated bibliography on infant stature covering studies made in North America prior to 1942, which should prove useful to research workers.

The author is to be commended for the excellence of this work especially Part I.

BYRON O. HUGHES
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STRUCTURE AND FUNCTION AS SEEN IN THE FOOT. By FREDERIC WOOD JONES. The Williams and Wilkins Co., Baltimore, iv + 329 pp., 1944.

Twenty-five years ago there appeared "The Principles of Anatomy as seen in the Hand," from the pen of Prof. Frederic Wood Jones. This book both stimu-

lated and greatly influenced many students of man: old, young and incipient — among the latter, the reviewer. The present volume is a companion work, although in it less attention is paid to general principles especially elaborated in the earlier publication and more space is devoted to the special principles concerned in the structure and functioning of the foot. As in many of his writings, the views of the author frequently are highly unorthodox and even daring, hence decidedly catalytic.

Most of the present volume deals with the form and functioning of the human foot. This part is presented with the author's customary clarity and originality, and some chapters, as those treating of the actions of muscles and joints (notably XVII, XIX, XXI), are splendidly conceived and executed. Indeed, they contrast markedly with similar discussions in many other works that deal with the foot. The chapters on digital formula (V), metatarsal formula (VI) and external characters (VII) will be of especial interest to the physical anthropologist. In the brief treatment of the papillary ridges (dermatoglyphics) one finds, however, no mention of the recent important studies of Cummins and Midlo, nor of the earlier investigations of Wilder and of Schlaginhaufen.

To one interested in human evolution, the most disappointing part of the book is that which is concerned with the comparative anatomy and phylogeny of the foot. Most of this material is concentrated in chapters III, IV, XIV, and XVI, with additional comments scattered through other sections. Neglect of the recent literature bearing upon this aspect of the treatise is a serious defect. For example, no paper of Schultz published later than 1926 is cited; and for the muscles, only two works that appeared since the turn of the century — the out-dated book of Sonntag ('24) and a paper by Patterson ('42) dealing with the myology of two Old World monkeys. The approach to the problem regrettably is essentially controversial in spirit, in an effort to maintain the author's thesis that "the human foot . . . is derived from a primitive mammalian foot" (p. 16) and that "the human and simian foot probably took common origin very early back in the story, from a foot of primitive mammalian type" (p. 30). This, it will be recognized, is a corollary of the author's well-known tarsioid theory of man's origin. In the opinion of the reviewer, the evidence presented falls short of justifying the thesis regarding the foot.

That part of the volume dealing with ontogeny is devoted largely to a demonstration of the early acquisition of human pedal characters, and to an attempt to prove that "man, in all ontogenetic stages, shows characters of foot architecture that are obviously derivatives of basal mammalian conditions but which it is quite impossible to admit could ever have been developed from any stage that had once assumed 'simian' characters" (p. 30). The author virtually rejects the 'Recapitulation Theory' as no more than a "useful guiding principle" (p. 18), yet he later invokes this very concept as a support for his arguments that there is no evidence that man ever possessed an opposable hallux (pp. 29, 217) and that the human foot is derived from one of "basal mammalian type" (p. 30), and as indicative of "a very early phylogenetic acquirement of a characteristically arched human foot" (p. 248). Whatever there may remain of validity in the recapitulation concept, certainly any implication that the phylogenetic dating of a structure can be based on its time of ontogenetic appearance is, to say the least, open to discussion.

The comparative treatment of the foot musculature contains a number of inaccurate statements and questionable interpretations. Space does not permit full discussion or even enumeration of these points. But it may be noted that the author's choice of "features in which the muscles of the human foot show a plan more primitive than that existing in any monkey" (p. 195) — a cardinal point in his argument — is highly debatable.

Considerable space is devoted to an attack upon the so-called "gorilloid" theory of human foot origin. With the author's general thesis, the reviewer is in full agreement. But Professor Wood Jones is tilting with a man of straw in his assault on the foot of the highland gorilla. Despite the several points in which it more nearly approaches the foot of man than does that of the lowland gorilla, it is doubtful whether serious students today would maintain that these are evidences of the transformation of a gorilla foot into a human one. Fifteen years ago, the reviewer demonstrated that, as regards the muscles, the foot of the highland gorilla is virtually identical with that of the lowland species, and in no sense intermediate between the feet of the latter and man.

Incidental to his specific argument respecting the foot, Professor Wood Jones points out that there are many valid reasons for believing that man could not have developed from an animal that might be considered an anthropoid ape, and that man is no made-over brachiator. In this, he is reiterating views that he previously had expressed. And in this, he will evoke full agreement in many of his readers.

This book undoubtedly will be read with great enjoyment and profit by workers in many fields. To students of human evolution, it should be highly fermentative. For Professor Wood Jones ever has been an opponent of smug academicism and complacent canonism, and he pulls no punches.

William L. Straus, Jr.
The Johns Hopkins University

ANATOMY AS A BASIS FOR MEDICAL AND DENTAL PRACTICE. By Donald Mainland. Paul B. Hoeber, Inc., New York, 863 pp., 1945. ($7.50)

"Anatomy" is divided into three parts: the first (150 pages) introduces the student to the problems and methods of anatomy; the second (600 pages) is a regional anatomy; and the third (100 pages) consists of useful appendices and an excellent bibliography. Mainland is concerned primarily with introducing the student to successful methods of thinking. Since he recognizes the intimate relation of thinking and doing, "Anatomy" is filled with specific directions, telling the student what he may do to get an understanding of the living human being. Since no book can be complete, a fact explicitly recognized by the author, each chapter is accompanied by a carefully selected list of references.

Traditionally the student of medicine dissects a human body with the aid of one of the standard systematic anatomies, an atlas, lectures, and numerous dissection directions. The great reference texts are so difficult that most students soon seek one of the shorter handbooks or compendiums. In the eyes of the student such shorter books are an essential part of the anatomy course, and many beginners buy three or four of them, vainly trying to find one which is satisfying.

Mainland's "Anatomy" is the latest addition to the growing list of shorter books. It is my belief that it is by far the best. From the student's point of view the principal difficulty with the encyclopedic texts is not length but organization. They do not provide any method of evaluating or appreciating the myriad facts which are presented. The majority of the shorter books suffer from the same difficulty. They are good regional, systematic, or surface anatomies, but they offer no guide to anatomical thinking. Because Mainland succeeds in presenting the fundamentals of anatomical method, the student who reads this book will be able to use reference books and the anatomical literature intelligently.

The contrast between Professor Mainland's concept of regional anatomy and the traditional one is best shown by an example. In describing the fibula it is stated that the "fibula bears no weight but has three functions," (1. For muscle attachment; 2. Forms the lateral part of the ankle socket; 3. Provides a pulley for the tendons of the peroneal muscles). Such a description prepares the student to understand the normal fibula, the effect of fibular fracture on the ankle joint, or the changing function of the fibula in evolution. In Mainland's regional descriptions anatomical principles are brought to bear on one part of the body to elucidate its anatomy. Emphasis is on the living, on function, and on clinical application. This is a far departure from traditional regional anatomy which is simply a description of what is found in one area of a cadaver.

This is the first book to integrate anthropology and medical anatomy. In a special chapter the student is introduced to variation and numerous references are made to the anthropological literature. Throughout the entire book variations, measurements, growth, and evolution are mentioned whenever the author feels them necessary. Fortunately for all, Professor Mainland disregards the boundaries between anthropology, anatomy, and clinical problems. The result is a synthesis which is beneficial to all and which suggests fertile fields for further research.

S. L. Washburn,
Department of Anatomy
Columbia University

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS

The fourteenth annual meeting of the American Association of Physical Anthropologists was held on March 24 and 25, 1945, at The Wistar Institute of Anatomy and Biology, Philadelphia, Pennsylvania. The business meeting was held Sunday morning. Dr. Krogman, Vice-President, presided in the regretted absence of the President, Dr. Weidenreich.

Since the last meeting of the Association there have been two elections by mail. In the Spring of 1943 Dr. Sherwood Washburn was elected Secretary-Treasurer; Dr. Morris Steggerda to the Executive Committee; and Dr. Montague Cobb, Associate Editor of the Journal. In the Spring of 1944, Dr. Wilton M. Krogman was elected Vice-President; Dr. William L. Straus to the Executive Committee; and Dr. Harold Cummins Associate Editor of the Journal.

The treasurer's report for 1942–44 was presented by Dr. Washburn, and approved by an Auditing Committee consisting of Drs. H. L. Shapiro and Loren C. Eiseley.

TREASURER'S REPORT

Bank balance, April 16, 1942		$629.30
Receipts (April–December, 1942)		
Dues		
Annual	$ 38.00	
Life	15.00	
Interest		
Bank deposit	4.03	
Prudence bond	9.01	
	$ 66.04	
		$695.34
Expenditures		
Guests at dinner, 13th meeting	$ 2.60	
To Royal Anthropological Institute	102.75	
Printing and distribution of Proceedings of 13th Annual Meeting	19.61	
Secretarial expenses	9.00	
	$133.96	
Bank balance, December, 1942		$561.38

Receipts, 1943		
Dues		
Annual	$344.00	
Life	44.00	
Interest		
Bank deposit	7.08	
Prudence bond	35.16	
	$430.24	
		$991.62
Expenditures		
To The Wistar Institute for the American Journal of Physical Anthropology	$228.03	
Secretarial expenses	2.70	
Election in May, 1943	10.00	
U. S. Savings Bond ($500.0)	370.00	
	$610.73	
Bank balance, December, 1943		$380.89
Receipts, 1944		
Dues		
Annual	$528.23	
Life	30.00	
Interest		
Bank deposit	7.09	
Prudence bond	6.26	
	$571.58	
		$952.47
Expenditures		
To The Wistar Institute for the American Journal of Physical Anthropology	$334.50	
1944 election	11.00	
Stamps	6.00	
Dues, Inter-American Society	3.00	
	$354.50	
Bank balance, December 31, 1944		$597.97

ENDOWMENT FUND

Prudence bond, approximate value	$225.00	
U. S. Savings Bonds, maturity value	3000.00	
		$3225.00

Respectfully submitted,
S. L. WASHBURN,
Secretary-Treasurer
March 25, 1945

Audited and approved:
HARRY L. SHAPIRO
LOREN C. EISELEY

The secretary reported the deaths of three of the Association's founders, Prof. Robert B. Bean, Dr. Charles B. Davenport, and Dr. Aleš Hrdlička.

The following were elected to membership in the Association:

E. H. Ackerknecht	R. R. Gates	N. A. Michels	S. L. Rogers
W. B. Atkinson	R. Linton	M. Miles	W. M. Rogers
A. Bullen	W. H. Kelly	R. C. Renes	M. W. Smith
P. Fejos	V. E. Krahl	C. A. Reed	W. S. Thompson
J. E. Flynn	D. Mainland	E. Richards	F. R. Wulsin

It was pointed out that, under present arrangements, the annual members were carrying more than a fair share of the financial burden of the Association. Dr. Hooten moved that the secretary be instructed to write to the life members to ask them to relinquish their life memberships. The motion was carried unanimously.

Dr. Howells, reporting for the Nominating Committee, offered the following nominations for office:

For President	Dr. Wilton M. Krogman
For Associate Editor	Dr. H. L. Shapiro
For Executive Committee	Dr. Mildred Trotter

Drs. Krogman and Shapiro were elected. Dr. Count offered the name of Dr. Dupertuis for Executive Committee from the floor. Dr. Dupertuis was elected.

Dr. Weidenreich was unanimously elected to represent the Association on the Committee on International Cooperation in Anthropology.

Dr. McCown was unanimously elected to represent the Association on the council of the Inter-American Society of Anthropology and Geography. Dr. Shapiro moved that the term be for 3 years. The motion was passed.

The Association voted to withdraw the privilege of life membership. (The motion that Sections 2, 3, 4, 5 should be omitted from Article 6 of the By-Laws was passed unanimously.) It was voted that the changes in the By-Laws, as printed in the American Journal of Physical Anthropology, new series vol. 1, no. 2, pp. 221–224, with the exception of the sections referring to life membership, be adopted.

Dr. Flynn, Editor-in-Chief of Biological Abstracts, told the Association about the possibility of starting a new section of the abstracts to be devoted to human biology. Dr. Montagu moved that the Association cooperate in every possible way with the program which Dr. Flynn outlined. The motion was passed unanimously. Dr. Zwemer moved that

Dr. Krogman and the committee who had worked with him on the annual Bibliography in the American Journal of Physical Anthropology form a committee to cooperate with Biological Abstracts. This motion also was passed unanimously.

The Association voted to appropriate not over $50.00 per year toward the expenses of Dr. Krogman's PA News Letter.

The secretary read the Editor's report on the American Journal of Physical Anthropology.

The report revealed that despite difficulties and problems incident mainly to the war emergency, the Journal has performed its functions in representative and progressive manner. At the suggestion of Dr. Farris, about a year ago the Editor began to prepare press releases on newsworthy articles scheduled to appear in the Journal, in an effort to popularize this information. Eleven such releases have been prepared. They are sent to The Wistar Institute for distribution to such news agencies as Science Service, Time Magazine and the science editors of certain daily papers.

On motion of Dr. Howells, the report was unanimously accepted.

Dr. Bowles moved that the Association approve all the actions which the Executive Committee had taken during the 3 years since the last meeting of the Association. This motion was passed unanimously.

Dr. Krogman expressed the thanks of the Association to The Wistar Institute for its hospitality, to Dr. Farris for his kindness, and to Dr. Angel who had made all the local arrangements for the Association.

Abstracts of the papers presented at the meeting follow.

1. *Anthropological survey of British school children.* R. E. G. Armattoe, Londonderry, North Ireland.

Investigations of 11,000 school and college children of Britain, Australia, New Zealand show that, compared to Britons of 1883, these children are less fairhaired, more brownhaired, and definitely taller and heavier. The teeth are better. Conclusion: Urbanization is detrimental to Nordic survival but beneficial to other stocks.

2. *The changes in human dentition.* A. A. Dahlberg, Chicago Natural History Museum.

Changes and modifications of form, size and number of human teeth are most manifest in the distal members of the incisor, premolar and molar series; namely, the lateral incisor, second premolar and third molar. Congenital absence, anomalous cusps, and changes from the fundamental occlusal or other surface patterns are relatively rare occurrences in the central incisor, cuspid, first biscuspid and first molar. Coefficients of variability for size increase in the progression from anterior to posterior member of each tooth group. The time elements, positional and correlative factors involved in the field concept of developmental dynamics are a likely explanation of the distribution of most tooth anomalies and variants in dentition.

3. *Hereditary and psychiatric aspects of cleidocranial dysostosis.* Samuel Kilgore and G. W. Lasker, Duke University Hospital.

Cleidocranial dysostosis is a congenital developmental disease in which ossification of the clavicles and skull is faulty. Dentition, face, vertebrae, phalanges, pelvis, etc. sometimes are involved. A case we have examined was schizophrenic, the son of a dysostotic father with normal mentality. The psychosis, however, seems independent of the inherent dysostosis but the deformity is reflected in the psychotic manifestations and probably influenced their development.

A simple autosomal Mendelian inheritance is involved in the etiology of cleidocranial dysostosis. In 51 families with multiple cases, 215 affected individuals are reported. The condition occurs in sons and daughters of affected fathers and mothers. Affected and normal siblings occur equally. Reported pairs of like-sexed twins are concordant. The sex ratios are approximately 1: 1. The condition has been reported in an affected mother's offspring by two different husbands.

There are many isolated cases of whom at least 24 had both parents normal. Recessive inheritance, however, is contraindicated by the rarity of consanguinity of parents and the lack of appropriate incidence ratios. The penetrance is nearly 100% for in the familial cases there have been only three sibships with parents negative. Possibly the isolated cases are to be ascribed to mutation, possibly to non-hereditary factors affecting the embryo similarly to the dominant gene of more typical cases.

4. *Constitutional studies at Hotchkiss School.* J. K. Bodel, Hotchkiss School.

A brief description of the constitutional studies program at Hotchkiss School, reporting the use of anthropometric and morphological observations and somatotyping in connection with the study of several phases of the adolescent boy's adjustment to a boarding school environment.

5. *Constitutional type and varicose veins.* J. Lawrence Angel and F. Wagner, Baugh Institute of Anatomy of the Jefferson Medical College.

Clinicians feel that constitution plays a part in causing varicose veins since "familial tendency" and obesity are often met. The small series so far studied (29 males, 38 females, is dominantly North European, with Old American, Central European and Balkan minorities. Known varicosities in sibs or parents of 40% of subjects and a statistically significant excess of blood group B (9 out of 35 cases) suggest a genetic factor, and tough occupations and many pregnancies (3.5 average) in the women show environmental stress a necessary factor.

Though mean age of just over 50 years makes metric comparison difficult the average varicose vein patient is excessively heavy, with broad and deep trunk, heavy-boned, with massive face and large nose. Somatotype ratings show excessive mesomorphy backed by more than average endomorphy. Although the endomorphic mesomorph and mesomorphic endomorph classifications together account for over half the series there is a definite cluster of slender physiques whose linearity is generally muscular. In many cases the limbs tend to exceed the trunk in muscularity and the role of the muscles in returning blood more efficiently through deep than through superficial veins may be of interest.

6. *The experimental approach to anthropological problems.* S. L. Washburn, Columbia University.

The interpretation of descriptive data requires a knowledge of biological processes, which must be obtained from controlled animal experimentation. Three sets of experiments dealing with the zygomatic arch, facial muscles, and interparietal bone of the rat were presented and the results discussed.

8. The interpretation of osseous anomalies with special regard to the premaxillary bone. Charles R. Noback, Department of Anatomy, Long Island College of Medicine.

Many of the controversies envolving the interpretation of the normal and anomalous developmental anatomy of bones can be traced to the observational methods employed. Some descriptions of the normal developmental anatomy of certain bones are based on the assumption that anomalies and other variations are a retention of an earlier developmental state which normally does not persist. These descriptions are often in conflict with the actual anatomy obtained by direct observation of the developmental anatomy of the bone. The problem of the overgrowth of the facial portion of the premaxilla by the maxilla in man is an example of such a controversy.

The essential evidence supporting the maxillary overgrowth concept is the presence of inconstant endofacial and intraalveolar sutures and of double inferior narial margins.

Maxillary overgrowth of the premaxilla in man probably does not occur. Direct observation of the early development of these bones does not show the progressive medial migration of the medial border of the maxilla. An ectofacial suture, when present, is always at its original site. The weak alizarinophilic staining reaction in the 3 month fetal premaxillary alveolar plate signifies slight osteogenesis in the area (active ossification is highly alizarinophilic). This evidence does not support the overgrowth concept. The occasional persistent (secondary) endofacial suture can be explained by evidence of resorption at the fused premaxillary-maxillary bone junction during the early fetal period.

9. Torsion of the humerus in man. F. Gaynor Evans and Vernon E. Krahl, Department of Gross Anatomy, University of Maryland, School of Medicine, Baltimore, Maryland.

Humeral torsion in man is the culmination of a process originating with the rise of the labyrinthodont amphibians from the crossopterygian fishes. It is a typical tetrapod characteristic probably produced by the interaction of a primary (hereditary) torsion upon which is superimposed a secondary (ontogenetic) torsion apparently resulting from muscular tractions, function, etc.

In the white race the mean torsion is significantly greater than that in American Negroes. It is also significantly greater in white males and in the right humerus. Sexual differences in torsion in the white race and those between the means for the females of the two races are insignificant. Among American Negroes torsion is significantly greater in the females but the differences between the sides are insignificant.

There is no apparent correlation between torsion and age in adults. In both races the longer humerus of a pair generally exhibits the greater torsion. The right humerus is usually the longer and thicker bone in both races. In whites the thicker humerus of a pair generally shows the greater torsion; in negroes, the thinner.

A distinction is made between torsion and rotation. Evidence from several sources indicates that torsion probably occurred in a medial direction. Handedness may be an important ontogenetic factor in humeral torsion. Inconclusive evidence suggests that the site of torsion is the region of the proximal epiphyseal cartilage.

10. Torsion of the human lower extremity. Herbert Elftman, Department of Anatomy, College of Physicians and Surgeons, Columbia University.

The torsions of the femur and of the tibia have proven of value as measurements of the individual bones but they are also of importance in determining the functional capacity of the lower extremity. In thirty-five male cadavers the torsion of the neck of the femur had a mean value of $11.9° \pm 1.1°$ and the torsion of the malleolar line averaged $27.4° \pm 1.3°$. The normal range of variation is large, the standard deviation for femoral torsion being 6.2° and for malleolar torsion 7.4°. There is no correlation between variations in femoral torsion and malleolar torsion. Consequently combinations occur which can markedly affect the function of the lower extremity.

13. The physical anthropologist and the study of human constitution. C. W. Dupertuis, Presbyterian Hospital, New York City.

Studies in human constitution cover entirely different ground than those of physical anthropology. For this reason it is suggested tht the physical anthropologist who contemplates doing constitutional research should modify his point of view and his techniques in accordance with the new problems he has to face. Traditional anthropological methods and statistical procedures are seldom applicable to constitutional studies. Physical anthropology deals with human groups; whereas constitution is primarily concerned with the individual and his reaction to his environment. Physical anthropology has to do with the purely physical aspects of man; human constitution considers all phases of the total personality.

14. Disproportions and personality. C. C. Seltzer, Harvard University.

This paper deals with the relation of disproportions in the physique of ''normal'' young men to certain personality traits. The data are derived from the researches of The Grant Study of Harvard University, an institution organized in 1938 for the investigation of the total personality of the ''normal'' individual.

Disproportions refer to extreme ranges of certain indices of body proportion. Their importance lies in their apparent association with personalities less well-organized and less capable of making easy social adjustments, as well as with motivations that are less practicable and perhaps less desirable. Individuals with these disproportions are more inclined to possess personality traits of a sensitive and complex nature such as: self-conscious introspective, inhibited, sensitive affect, unstable autonomic function, cultural, asocial ,and ideational. Individuals who are free of disproportions are clearly inclined toward the stronger and more stable personality traits such as: vital effect, practical organizing, pragmatic, sociable and well-integrated personality.

15. Some problems in constitutional case study. A. K. Bullen, Harvard University.

The present progress report deals with investigations being carried on at the Fatigue Laboratory, Graduate School of Business Administration, Harvard University. The problem of individual variation in susceptibility to nervous and mental fatigue is being studied in its physical, psychological, and social aspects. The initial series includes seven women and fourteen college men seen for interviews and tests over a prolonged period of time.

The research includes anthropometric measurements, body build description, temperament and personality evaluation, medical and social data, and physiological and psychological findings from specific tests and interviews.

16. Sex differences in pubic hair distribution.[1] William B. Atkinson, C. W. Dupertuis, Herbert Elftman. Columbia University.

In order to determine the value of pubic hair pattern as a secondary sex character, photographs of 1060 men and 309 women have been studied. The classical division into ''masculine'' and ''feminine'' types has been found to be unsatisfactory. A more adequate classification recognizes four types, designated as horizontal, sagittal, acuminate and disperse. The acuminate or ''masculine'' type is present in one-half of the men and one-tenth of the women. The horizontal or ''feminine'' type is the definitive type for nine-tenths of the women. It is also the basic type for male adolescents, is characteristic of 38% of 18-year-old males and persists in 17% of adult men. The decrease in frequency of the horizontal pattern with age in men is associated with an increase in general hirsutism and is accompanied by the development of a disperse pubic hair pattern.

[1] In press, Human Biology.

17. Age changes and sex differences in the prepuberal distribution of subcutaneous tissue. Earle L. Reynolds, Fels Research Institute, Antioch College.

This is a progress report on a serial roentgenologic study of the distribution of subcutaneous tissue in the body. Fifty Fels children of each sex, with an age-range of 6½ through 14½ years, are reported on here. About 500 sets of roentgenograms, each set containing eight representative areas of the body, are available on these subjects.

Preliminary findings presented in this report indicate that, between 6½ and 9½ years, the mean subcutaneous tissue breadths for the girls exceed the corresponding values for the boys for every area considered. Girls also tend to greater variability.

There is a fairly high association between the breadth of the subcutaneous tissue in one area with the breadth in other areas, in the same child. There are, however, many individual exceptions to over-all patterns of generalized fat distribution, and the examination and classification of individual distribution patterns is underway. Twins show extremely similar fat distribution patterns.

The various fat breadths show a moderately close association with body weight, with a somewhat less close association with body height. The relation of each of the eight fat breadth categories to other anthropometric values was also examined. These associations tend to increase with age, but no one area appears to be diagnostic of general fat distribution.

18. Cooperation in anthropology with other countries. R. L. Zwemer, U. S. Department of State.

In the dealings of one nation with another there are three basic approaches: (1) Government to government or the political approach; (2) material things and financial or the economic approach; and (3) people to people or the cultural approach. For complete understanding, all three should be in harmony and directed toward one end. The maintenance of peace is based on understanding.

As part of the third method, the Interdepartmental Committee on Cultural and Scientific Cooperation is active in helping to mobilize and integrate those activities of the United States Government which are directed toward our sister republics to the South.

Unquestionably, among the most valuable contributions of such a program are the true understanding, mutual respect, and sympathy which are brought about by daily contacts and joint undertakings. It also gives an opportunity to demonstrate that scientific attainments in the United States are not limited to physical and biological sciences, as commonly supposed, but are also developed in the field of human relations. Unfamiliar with our work in social sciences, the other American republics have traditionally looked to Europe for training in this field.

A program of this nature is free from political implications and criticism of imperialistic tendencies or ''giving'' where gifts are not sought and where nothing is given in return. The end of the war will open the way for world-wide collaboration of scientists, and it will be their opportunity to carry forward the democratic ideas and ideals of this country.

23. Race mixture and cultural change. J. Lawrence Angel, Baugh Institute of Anatomy of the Jefferson Medical College.

Skeletal evidence can now destroy positively the fancy that cultural efflorescence in historically critical Greece was the achievement of an inbred Nordic aristocracy. Skeletal material shows ancient Greeks to have been notably heterogeneous, with mean variability 7% above normal and a diversity expressed in six arbitrary types. Continuity from prehistoric to modern times is striking, both culturally and genetically. But cultural, ethnic and racial changes occur parallel with one another, continuously, and with partly cyclic fluctuation depending on invasions, emigrations, and social selection relative to population growth and ecology. The

rise to phases of high achievement is not regularly linked with excess of the same type or types: it is type combination which is characteristic.

Thus cultural rise is associated with racial fusion through hybridising of an originaly genetically diverse population, as seen clearly in the reduction in mean variability which precedes the great Greek cultural efflorescence. Hybrid vigor, multiplication of genetic possibilities influencing temperament as well as body, and the active evolutionary potential which S. Wright has shown typical of such a situation combine with cultural changes like improvement in diet (with consequent rise in body size) to produce a vigorous people capable of making the most of diverse cultural influences. And diversity of bodily appearance may have been culturally more than genetically associated with behavioral diversity and thus added to the stimulating social role of race mixture.

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Term expiring 1948 .... C. W. Dupertuis

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HUMERAL TORSION IN MAN

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TWO FIGURES

INTRODUCTION

The phenomenon of torsion or twisting occurs in many bones of the human skeleton, e.g. the scapula, innominate, and the astragalus, but it is most clearly evident and has been most thoroughly studied in the long bones of the extremities, especially the humerus and the femur. In addition, the course of some of the nerves, blood vessels and muscles indicates that the extremities as a whole have also undergone a process of torsion during ontogeny.

With respect to the skeleton, torsion has probably been most thoroughly studied in the humerus and anatomists have been cognizant of the twisted appearance of the humerus since Bertin mentioned it in 1754. Winslow (1763) also remarked that the spiral groove of the humerus suggested a twisted bone while Cruveilhier (1851) briefly mentioned humeral torsion in homologizing the humerus and the femur. Since then, considerable interest has developed in the problem of humeral torsion and many theories have been advanced to explain the nature of the process that produces it.

The first detailed theory of humeral torsion was that proposed by Charles Martins (1857), a French botanist, although the previous year Meyer (1856) had figured the superimposed ends of the human humerus and measured the acute angle formed by the two joint axes. However, he made no mention of torsion.

Charles Martins had noticed torsion occurring in plant stems and pointed out its analogy to that seen in the humerus of man. He judged that the humerus of man, apes, and quadrupedal mammals had been twisted through nearly 180°, giving the presence of the spiral groove as proof. This torsion he considered to be ''virtual'' rather than actual and, like many of the other early investigators, he was primarily interested in homologizing the superior and inferior extremity of man.

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Humeral torsion was also studied by Meyer (1861), Gegenbaur (1868), Schmid (1873) and Albrecht (1875). Gegenbaur measured the torsion angle in human fetuses, infants and adults, showing that torsion increases with age. In contrast to Martins, he believed this torsion to be an actual one. Schmid and Albrecht both opposed the idea of torsion although the former investigated the phenomenon in a large number of lower quadrupeds in addition to making accurate measurements on human humeri. Albrecht located the twisting of the superior extremity entirely in the forearm.

One of the most comprehensive and outstanding studies of humeral torsion is the one made by Broca (1881) who carefully measured the torsion angle in over 600 human humeri as well as those of about 150 lower mammals. He confirmed Martins' and Gegenbaur's work and showed a gradual increase in the torsion angle as one ascends the phylogenetic tree from the recent monkeys through the great apes to modern man.

Broca's work was extended by Durand (de Gros) (1887) who, although chiefly concerned with the homology of the limbs, made observations on the humeri of lower mammals, some reptiles and a few fossils. Sappey (1888) briefly mentions humeral torsion while Holl (1891), in opposition to the Martins-Gegenbaur theory, did not admit a humeral torsion at all.

Since the work of Broca, the most intensive and thorough studies of humeral torsion have been those of LeDamany ('03) and Rouffiac ('24). The former substantiated the ontogenetic findings of Gegenbaur but believed that humeral torsion only occurs in man despite the fact that he studied lower vertebrates including a few fossil reptiles. Rouffiac studied the phenomenon thoroughly in man viewing it from the standpoint of development, structure and function.

Other, less complete studies of humeral torsion have been made by Lucae (1865, 1866), Matthews et al. (1893), Krause ('09), Grunewald ('19), Athayde ('32), C. P. Martin ('33) and Chillida ('43). The twisted appearance of the humerus has also been noted by Gegenbaur (1898, '10), Braus ('06, '29), Keith ('33) and Howell ('39).

Recently the origin and evolution of humeral torsion from the crossopterygian fishes to man has been studied by Evans and Krahl ('45) who postulate a primary (hereditary) torsion upon which is superimposed a secondary (ontogenetic) torsion. Furthermore, they show that torsion increases during the evolution of man and believe that

secondary (ontogenetic) torsion results from the pull of muscular forces, function, etc. and that torsion has occurred in a medial direction.

In spite of the rather extensive work that has been done on humeral torsion most modern text books of human anatomy make little or no mention of it or confuse it with the rotation which the entire superior extremity undergoes during ontogeny. Thus, in the latest edition (24th, '42, p. 66) of Gray's "Anatomy of the Human Body" the statement is made that the limbs undergo "a rotation or torsion through an angle of 90° . . ." while in the 4th edition ('40, p. 159) of Arey's "Developmental Anatomy" the limbs are said to "undergo a torsion of 90°." Torsion of the humerus is not mentioned in the latest edition (10th, '42) of Morris' "Human Anatomy" but in the current edition (8th, '43) of Cunningham's "Text-book of Anatomy" the superimposed proximal and distal ends of the humerus are figured (p. 238) and a brief mention of torsion is made (p. 243). Piersol ('30, 9th ed., p. 269), however, has a short paragraph on humeral torsion.

In view of the confusion in the literature between the phenomena of torsion and rotation and of the conflicts among the various theories advanced to explain the cause, direction and site of torsion the present study, a supplement to our preceding paper (Evans and Krahl, '45), was undertaken in a further attempt to clarify some of these problems. Having considered torsion in lower forms in the earlier work our attention will be confined here to a comparative study of humeral torsion in members of the white race and in American Negroes.

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MATERIALS AND METHODS

The material used in this study consisted of the humeri of eighty-nine white individuals and of forty-nine American Negroes. The humeri of

the white individuals are in the Huntington Collection of the U. S. National Museum while those of the negroes are in both the Huntington Collection and that of the University of Maryland, School of Medicine.

In measuring the torsion angle the reference line used for the humeral head generally passed through the greater tuberosity approximately between the insertions of the supraspinatus and of the infraspinatus muscles (fig. 1). This line, of course is subject to some variation because of slight irregularities of the bone.

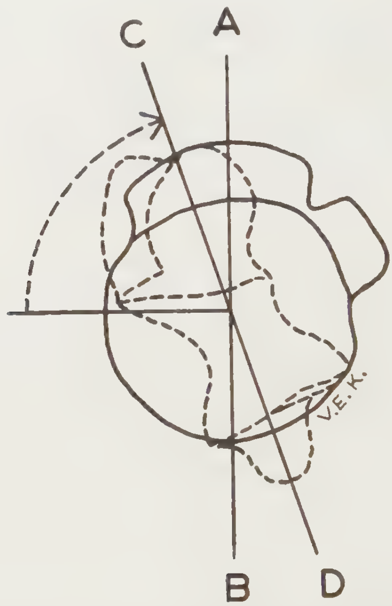

Fig. 1 Diagram of the superimposed ends of a left humerus to illustrate the angle measured. The outline of the proximal end is represented by a solid line and that of the distal end by a broken line. AB is the axis of the proximal end of the humerus and CD is the articular axis of the distal end of the humerus. The arrow indicates the angle measured and the direction of torsion. The 90° axis shows the extent of the lateral embryonic rotation of the entire limb.

The reference line employed for the distal end of the humerus was the articular axis which passes through the center of both the capitulum and of the trochlea. The angle formed by the crossing of these two reference lines was then measured with the Torsiometer, an instrument recently designed by Krahl ('44). This angle is called the torsion angle.

In order to test the accuracy of our technique repeated measurements were made on the same humerus. The standard error was found to be $\pm 1°$.

Two different methods of expressing the degree of humeral torsion have been used in the literature. The French workers have generally expressed humeral torsion in terms of the obtuse angle while most of the German investigators have measured the acute angle. We believe, as earlier pointed out by LeDamany ('03), that those who have measured the obtuse angle erroneously included in their measurements the 90° rotation which the entire limb undergoes in embryology. As will be shown later, rotation and torsion are two distinct phenomena and, in order to obtain the true value of humeral torsion in cases where the obtuse angle was measured, it is necessary to subtract 90° which represents the embryonic rotation of the limb. Consequently, the maximum amount of humeral torsion, instead of being in the neighborhood of 180°, as those who have recorded the obtuse angle believe, is approximately 90° or less and our measurements of the torsion angle are based on this idea.

HUMERAL TORSION IN MAN

In table 1 are presented the values found for the average humeral torsion angles in eighty-nine white individuals and in forty-nine American Negroes.

TABLE 1

Humeral torsion averages (degrees) in man.

NATIONALITY	NUMBER OF INDIVIDUALS	MALE			FEMALE			TOTAL LEFT	TOTAL RIGHT	TOTAL NATIONALITY
		Left	Right	Both	Left	Right	Both			
White race										
Austrian	2 M	76.5	80.5	78.5				76.5	80.5	78.5
English	3 (1 M; 2 F)	68.0	65.5	66.8	64.8	76.5	70.6	65.9	72.8	69.4
French	1 F				86.5	87.0	86.8	86.5	87.0	86.8
German	8 (7 M; 1 F)	74.7	78.1	76.4	80.5	84.0	82.3	75.4	78.8	77.1
Irish	20 (6 M; 14 F)	70.4	73.3	71.9	74.5	79.5	77.0	74.3	77.6	75.95
Isle of Man	1 M	79.0	86.5	82.8				79.0	86.5	82.8
Italian	16 (14 M; 2 F)	71.3	76.3	73.8	77.3	76.3	76.8	72.1	76.3	74.2
Scottish	2 M	77.3	81.5	79.4				77.3	81.5	79.4
American	36 (24 M; 12 F)	71.6	75.4	73.5	70.4	74.8	72.6	71.2	75.2	73.2
Total White	89 (57 M; 32 F)	71.8	75.9	74.4	74.0	77.7	75.4	72.2	76.5	74.4
American Negroes	49 (28 M; 21 F)	69.1	68.2	68.7	75.7	75.5	75.6	71.9	71.3	72.6

In spite of the great range of variation (37°) in humeral torsion among members of the white race, an examination of table 1 reveals that the average degree of humeral torsion is greater on the right side than on the left in all the nationalities studied. This difference usually amounts to several degrees except in the single French individual where it is only .5° greater on the right side. Furthermore, the average degree of humeral torsion is greater in the females of all nationalities, where both sexes are represented, except the Americans. Here the difference between the sexes is only .9° which, as in the case of the French individual previously mentioned, has no significance as it is within the range of the standard error (± 1°) of our technique. The average degree of torsion for all our white individuals is just 1° greater in the female.

In comparing the various means for members of the white race and for American Negroes the formula:

$$\frac{M_1 - M_2}{\sqrt{(\epsilon_1)^2 + (\epsilon_2)^2}}$$

was employed (Burns, '37, p. 29) where M = the mean and ε = the standard error of the mean. This was used to determine whether the differences are truly significant ones or only because of chance. The quotient obtained with this formula will subsequently be called the critical ratio. When this quotient is greater than 2 (Probability = .05) the difference between the two means is considered to be a significant one.

The mean torsion (table 2) of the right humerus in the white race is 4.4° greater than that of the left. That this difference is a true and highly significant one is indicated by the fact that it is much more than twice the standard error and also by the critical ratio of the two means (left and right) which is 3.7.

Although, in the white race, the mean for the females (table 2) is slightly greater than that for the males it has no significance as it is within the range of the standard error of our technique and the critical ratio of the two means (male and female) is only .3. However, the range of variation is 6° greater in females.

In the American Negro (table 1) the average degree of torsion is less than in the white race. However, in contrast to the latter, the torsion angle is very slightly (.6°) greater in the left humerus than in the right and is considerably greater in females than in males. The range of variation in American Negroes as a whole is practically the same as in the white race. The greater torsion of the left humerus is insignificant as it is within the range of the standard error of our technique. The average humeral torsion in man (white plus American Negroes) is 73.8°.

TABLE 2

Statistical analysis of humeral torsion in 89 white individuals.

	NUMBER OF HUMERI	RANGE OF VARIATION	MEAN	STANDARD DEVIATION	STANDARD ERROR OF THE MEAN ϵ
Total L and R					
M	114	6–87°	74.8°	± 8.3°	± .6°
F	64	51–88°			
Male L and R	114	56–87°	75.5°	± 7.7°	± .7°
Female L and R	64	51–88°	75.8°	± 9.3°	± 1.2°
Right					
M	114	61–87°	77.0°	± 7.1°	± .8°
F	64	59–87°			
Left					
M	114	56–87°	72.6°	± 8.8°	± .9°
F	64	51–88°			

TABLE 3

Statistical analysis of humeral torsion in 49 American Negroes.

	NUMBER OF HUMERI	RANGE OF VARIATION	MEAN	STANDARD DEVIATION	STANDARD ERROR OF THE MEAN ϵ
Total L and R					
M	56	50–88°	71.7°	± 10.7°	± 1.1°
F	42	52–88°			
Male L and R	56	50–88°	68.7°	± 10.9°	± 1.5°
Female L and R	42	52–88°	75.7°	± 9.2°	± 1.4°
Right					
M	56	50–88°	71.6°	± 11.0°	± 1.6°
F	42	52–88°			
Left					
M	56	50–88°	69.8°	± 10.7°	± 1.5°
F	42	52–88°			

A statistical analysis of our measurements in the American Negro (table 3) shows that the difference between the males and females is a truly significant one. It is more than twice the standard error of the mean and the critical ratio of the two means (male and female) is 3.4.

In the white race the mean torsion is 3.1° greater than that in American Negroes. Although this is a small difference it is still a significant one, though just barely so, as the critical ratio of the two means (white and Negro) is 2.5.

In comparing the males of the two races the mean is seen to be 6.8° greater in numbers of the white race than in American Negroes. This is a highly significant difference as is evident from the critical ratio of the two means which is 4.1. However, the difference between the means for the females of the two races is insignificant.

Comparison of the means for the left and right humeri in the two races also yields interesting results. The mean for the right humerus is 5.4° greater in the white race which is a very significant difference as indicated by a critical ratio of 3.0. The difference between the means for the left humeri of the two races has no significance.

In our material, all adult humeri, we find no correlation between age and the torsion angle. Although there is some correlation between humeral length and the degree of torsion the plotting of one character against the other shows it is not a highly positive one. In 2% of the white race and in 10% of the American Negroes both humeri of a pair are of the same length while in 2% of each race both members of a pair have the same torsion angle. If the members of a pair differ in torsion angle and in length the greater torsion more often (63% in the white race; 56% in American Negroes) occurs in the longer humerus of the pair.

When the sexes of the white race are considered separately the following results are obtained. In 4% of the males both humeri of a pair are the same length, while in 2% of the males and in 3% of the females both humeri of a pair have the same torsion angle. When the two humeri of a pair differ in length and torsion angle the greater torsion occurs more frequently (63% of the males; 71% of the females) in the longer bone.

Among American Negroes both humeri of a pair are the same length in 7% of the males and in 14% of the females. In addition, 5% of the latter have the same torsion angle in both humeri of a pair. When the members of a pair vary in length and torsion angle the higher torsion is more often (58% of the males; 53% of the females) found in the longer humerus.

Since it has been reported by Lambert (1892, p. 243) that the degree of torsion is inversely proportional to the thickness of the bone, the diameters of 135 humeri were measured. Measurements were made at the level of the apex of the "deltoid V" (as was done by Lambert) and also at the level of the proximal epiphyseal line since LeDamany ('03 b, p. 333) and Rouffiac ('24 p. 40) believed the proximal epiphyseal cartilage to be the site of torsion. Our measurements, taken at the apex of the "deltoid V", do not substantiate in the white race the inverse relationship of torsion and thickness found by Lambert and confirmed by Rouffiac ('24, p. 34).

The following relationships were obtained using the values for thickness at the proximal epiphyseal line. In 27% of the white race and in 21% of the American Negroes both humeri of a pair are of the same thickness, while in 2% of each race both members of a pair have the same torsion angle. However, the two races differ when a variation in the thickness of the members of a pair exists. In the white race the greater torsion occurs more frequently (68%) in the thicker member of a pair, while in American Negroes the thinner bone more often (74%) exhibits the greater torsion.

If the sexes of each race are considered separately the following results appear. In the white race 31% of the male individuals have the same thickness in both members of a pair of humeri, while in American Negro males it occurs in 22% of the individuals. Males of the white race also have the same torsion angle in both humeri of a pair in 2% of the individuals. The males of the two races exhibit marked differences when the members of a pair of humeri vary in thickness. In the white race the thicker member of a pair more often (68%) shows the greater torsion while among American Negroes it is more frequently (73%) seen in the thinner bone.

The females of both races have the same thickness in each humerus of a pair in 19% of the individuals. American Negro females also have the same torsion angle in both members of a pair in 5% of the cases. However, if the members of a pair vary in thickness and in torsion angle marked differences between the females of the two races are evident. In the white race 68% of the females have the greater torsion in the thicker humerus of a pair, while among American Negro females the thinner humerus of a pair has the higher torsion angle in 75% of the individuals.

Thus, the relation of the torsion angle to the thickness and to the length of the humerus is not the same. In both races the longer humerus

more frequently has the greater torsion, but the relation of torsion to humeral thickness differs in the two races. In the white race the greater torsion more often (68% in each sex) occurs in the thicker humerus of a pair while in American Negroes the thinner member of a pair usually (73% in males; 75% in females) possesses the higher torsion angle.

A study of the relation of humeral length and thickness to each other and to body side (right and left) yields the following results. In both races, when the members of a pair of humeri differ in length and in thickness, the right humerus is generally the longer (83% white race; 77% American Negro) and the thicker (73% white race; 66% American Negro) bone. The longer bone is usually (65%) also the thicker one.

DISCUSSION

Although anatomists have been aware of the twisted appearance of the humerus since the middle of the 18th century and have done a great deal of work on the subject, a source of considerable confusion in the literature has been the lack of a clear distinction between torsion and rotation. The two terms are not synonyms although they have frequently been used as such, e.g. latest edition of Gray's "Anatomy of the Human Body" ('42, 24th ed., p. 66) states that the limbs undergo "a rotation or torsion through an angle of 90°."

Rotation refers to a turning of the entire humerus around its long axis, a process which does not change the relationship of the two ends of the bone to each other. Furthermore, students of the embryology of the limbs (Grunewald, '19, p. 104) agree that the change in the position of the extremity skeleton occurs very early in embryonic life and that the axial turnings (rotations) do not represent torsions (twisting).

Torsion, on the other hand, refers to a twisting of one end of the humerus with reference to the other end so that the axes of the opposite ends of the bone come to lie in different planes. This torsion or twisting takes place about the long axis of the humerus but, in contrast to rotation, there is no turning of the entire bone about its long axis. The angle made by the crossing of the axes of the opposite ends of the humerus is called the torsion angle and its value can be expressed either as an obtuse or an acute angle. The majority of the French authors have used the former while most German workers have used the acute angle.

As mentioned in the introduction, Charles Martins believed that humeral torsion was only "virtual" but the majority of subsequent workers have concluded that a real torsion exists although there is a difference of opinion as to how widespread the phenomena is among

the tetrapods. LeDamany ('03) and C. P. Martin ('33) believe it is a unique primate character, an opinion which our earlier investigations as well as those of the majority of other workers do not confirm.

In contrast to most investigators of the subject, Albrecht (1875) did not admit the existence of humeral torsion, even in man, but believed the twisting of the upper extremity occurred in the forearm. This opinion was based upon the study of a series of vertebrate limbs from which he concluded that the radius originally lay medial to the ulna and that its present lateral position resulted from a 180° rotation of its proximal end about the ulna. Thus, the forearm bones were originally parallel and the later crossed position could be eliminated, in higher mammals, by supination.

Later Braus ('06, p. 250) partially supported Albrecht's conclusion by reporting that in the human embryo the proximal end of the radius anlagen experiences a circumduction movement around the proximal end of the ulna from a ventral to a cranial position. However, he emphasized that this positional change in the forearm bones is entirely independent of the torsion of the humerus.

Albrecht was thus dealing with a rotation through pronation and supination; not a true torsion. Later, Holl (1891) also denied the existence of humeral torsion but his and Albrecht's opinions have been refuted by many investigators.

Another subject of considerable speculation has been the cause of humeral torsion. Le Damany ('03), Rouffiac ('24) and C. P. Martin ('33) believe torsion is produced by muscular tractions acting in opposite directions on different parts of the humerus. However, Martin erroneously believes that torsion occurs only in primates where, he states, it is produced by using the fore-limbs "as a tensile organ for supporting the body when suspended from an object overhead in a manner which is quite peculiar to them", an idea refuted in our earlier paper. Holl (1891), Fick ('04), Grunewald ('19) and Braus ('29) all believe that the ontogenetic increase in the torsion of the human humerus, observed by Gegenbaur and later confirmed by LeDamany, is produced by the dorso-ventral flattening of the thorax accompanied by the dorsal migration of the scapula.

In our opinion there is no single cause of humeral torsion since, as we have earlier pointed out (Evans and Krahl, '45), torsion of the humerus is a palaeotelic tetrapod character probably resulting from the interaction of a primary (hereditary) torsion upon which is superimposed a secondary (ontogenetic) torsion produced by muscular forces, function,

etc. Therefore, muscular tractions and the dorso-ventral flattening of the thorax associated with the dorsal migration of the scapula, both of which are adaptations to the erect posture, are jointly involved in the production of the secondary (ontogenetic) torsion of the humerus. Thus, the values for the torsion angles given in the preceding section of this paper are a measure of the summation or end result of the interaction of the factors producing primary and secondary torsion.

In measuring the torsion angle of a post-fetal humerus it is at present impossible to distinguish between the effect of the primary and secondary torsion factors. However, some recent experiments cited by Murray ('36, pp. 6–7, 14) show the influence of the hereditary factor in determining the shape of long bones. Chorio-allantoic grafts of parts of 4 and 5-day chick limb buds and isolated femora from 6-day chick embryos show decided tendencies for exhibiting both of the normal curvatures of the femoral shaft. In other similar experiments a femur was obtained with a well developed head, another with condyles. Only the limb bud was used in the grafts and in other experiments the muscles were removed. Since, in these grafts, the normal form, curvatures and articular surfaces of the femur and humerus developed in the absence of other skeletal parts and of muscular forces, it is very probable that some degree of torsion was also present. As Murray suggests (pp. 6–7, 68–93), it seems probable that the intrinsic (hereditary) factors in bones are the determinative ones in the early stages, while the extrinsic factors (function, muscular pull, etc) come into play later. The latter factors probably account for the 20° to 30° increase in torsion the humerus undergoes from the third month of intra-uterine life until it attains the adult condition (LeDamany, '03, p. 332).

The effect of function on secondary (ontogenetic) torsion has been clearly demonstrated by Wermel ('35, p. 184) who experimentally induced an increase in humeral torsion in rabbits. This was done by a series of operations on the forearm bones, each of which produced a lateral turning of the hand on the operated side with a consequent abnormal function. In some cases a piece from the middle of the ulna was removed; in others the distal end, either with or without the epiphysis. In still other experiments the radius was either completely extirpated or all of it except the distal epiphysis. This operation was sometimes combined with cutting of the brachial nerve and in two animals only the nerve was cut. All operations were performed on the right side, the other side being left intact as a control.

The resulting abnormal functioning of the hand induced a series of changes in other parts of the same limb among which was an increase in the torsion of the humerus, that in the humerus of the operated limb being from 3° to 37.5° greater than in the humerus of the intact, control limb.

Wermel (cited by Murray, '36, p. 71) has also shown that function effects the length of the humerus as well as its torsion. Thus, in young rabbits, rats, and dogs a complete or partial removal of one of the forearm bones produced an increase in the thickness of the other and a relative elongation of the humerus on the operated side. That these changes were the result of an increased functional activity is shown by an experiment on two rabbits in which, after the same kind of an operation plus nerve section to prevent functional activity, there was practically no asymmetrical growth of the humeri.

Function has also been shown to effect humeral length in man. Jones (Wilde, '34, p. 110) has found a positive correlation in man between the greater development of certain anatomical characters of the superior extremity and handedness. Among the characters he studied was the length of the humerus which was found to be longer on the right side in right-handed individuals and vice versa. Wile (p. 182) also cites Yoshioka to the effect that there is a slight correlation between the longer bones of a dominate limb and handedness in rats.

Unfortunately we have no direct data on the handedness of the individuals whose humeri we measured but the results of Wermel's and of Jones' work provide the possibility of a functional as well as a hereditary basis of explanation for some of our findings.

As previously pointed out, the right humerus in both the white race and in American Negroes is generally the longer and the thicker bone. Furthermore, in the white race the right humerus also has the greater torsion angle while in the American Negro the left humerus exhibits the greater torsion although the difference between the two sides (.6°) is so slight that it has no significance.

Application of the results of Wermel's and of Jones' work to our material would indicate that 83% of our white individuals and 77% of our American Negroes were probably right-handed because the right humerus is the longer bone in these percentages of our material. This, in turn, implies that 17% of our white individuals and 23% of our American Negroes were left-handed as in these percentages of our material the left humerus is the longer bone.

The possibility that 17% of our white individuals and 23% of our American Negroes were left-handed may seem to be too large a proportion to many, but Wile ('34, p. 68) cites several investigators, working with European material, who found that from 25% to 30% of the population are left-handed. Wile (p. 76) also states that Lattes found that left-handedness is more frequent among Negroes.

Assuming that the majority of our individuals were right-handed and and with a consequently more powerful musculature in the right arm, we might expect to find a greater torsion in the right humerus as muscular pull and function are known to be important ontogenetic factors in osseous torsion.

The fact that the bodies of our white individuals were turned over to an anatomical dissecting laboratory would seem to indicate that these people belonged to the lower and poorer strata of society and were probably accustomed to hard physical labor of the kind that develops a powerful musculature. Irish and Italians together constitute 35% of our white males and it is well known that men of these nationalities, especially in the days when the Huntington Collection was made, composed a large proportion of labor gangs doing hard physical work. Women of the same nationalities form 50% of our white females and they also are frequently employed at work requiring considerable physical strength.

The greater average degree of torsion in the white race, as compared with the American Negro, is probably in large measure a hereditary difference. The same may be true of the differences between the average torsion angles in the males and in the right humeri of the two races.

The slightly greater average torsion (.6°) in the left humeri of American Negroes is of no significance, but the significantly greater average degree of torsion in the females of the race is difficult to explain. Perhaps it is a hereditary racial trait as Briffault ('27, v. 1, pp. 443–444) cites statements of numerous travelers to the effect that in many African Negro tribes the women are larger, stronger, better developed than the men and are able to carry loads that the men cannot lift. In the white race we found no significant sexual difference in the average degree of humeral torsion.

The most extensive study of humeral torsion in man is that made by Broca (1881) who measured over 600 humeri of various races. He found that the maximum degree of torsion occurs in the white race with an average of 164.0° while Gegenbaur gives an average of 168° for man as a whole. If these figures are expressed in terms of the angle measured

by us they become 74° (164°—90°) and 78° (168°—90°), respectively. Broca's average is almost identical with ours (74.4°) for the white race while the higher average of Gegenbauer is probably because of the small number of humeri he measured.

Broca also found that in nearly the whole series the torsion is greater in the left humerus than in the right and greater in females than in males. Similar results have been reported by other European workers but, unfortunately, none of them have analyzed their results statistically so we do not know whether the differences they have found are real ones or only because of chance in the sampling.

However, when the total torsion averages for Broca's white individuals, represented by the first three groups (French; other Europeans; Paris, St.-Marcel) in his table D, are calculated it is found that in the 85 males the averages for the left and right humeri are 70.86° (160.86° — 90°) and 71.28° (161.28° — 90°), respectively. Thus, the torsion of the right humerus is very slightly (.42°) greater than that for the left. In the 30 females the averages for the left and right humeri are 77.81° (167.81° — 90°) and 72.14° (162.14° — 90°), respectively, that for the left being 5.67° greater. The total average (left and right) for the 85 males is 71.1° (161.1° — 90°) and for the 30 females is 74.95° (164.95° — 90°).

Broca's averages are a little less than we found in our series of eighty-nine white individuals. However, in contrast to his results, we found the average degree of torsion in the right humerus to be 4.1° greater in the male and 3.7° greater in the female than that in the left humerus.

The average degree of humeral torsion found by Broca is 3.85° greater in the female, which is probably a significant difference. However, in the same three groups mentioned above, the difference between the average degree of torsion for all the left humeri, 72.67° (162.67° — 90°), and that for all the right, 71.42° (161.42° — 90°), is only 1.25° in favor of the left side. This is not a significant difference as it is well within the range of the error of his technique, Broca stating that a trained observer using his Tropometer could make measurements accurate only within 2 or 3 degrees. Therefore, the greater torsion of the left humerus, reported by Broca, has no significance in the white race as represented by the first three groups (French; other Europeans; Paris, St.-Marcel) in Broca's table D.

Broca also recorded some measurements for Negroes but, since he did not state exactly what type of Negroes they were, we will not comment on his results. In our case we have specified that American

Negroes were studied. The reason for this is that we have no way of knowing how much mixture of white blood, or perhaps that of Indians, was present in the individuals whose humeri we measured. We attribute the fact that the difference between our mean for the white race and that for American Negroes is just barely statistically significant to a high percentage of white blood in our Negro population. In a later paper we hope to study the degree of torsion in the humeri of African blacks which would more probably be full blood Negroes.

All investigators, who have studied torsion in other races besides the white, have found the highest average degree of torsion occurring in the white race. Matthews et al. (1893, p. 259), studying humeral torsion in the Salado Indians, reported an average torsion angle of 69° (159° — 90°), a figure considerably lower than our average for American Negroes. Their average torsion angle for other Indian tribes is even lower, 63° (153° — 90°), but some preliminary measurements we have made on Mohawk Indian humeri show that much greater torsion angles occur in some American Indians.

Recently Chillida ('43, p. 20) has studied humeral torsion in 15 different groups of Argentine aborigines in which he finds torsion angles varying from 54.14° (144.14° — 90°) to 68.1° (158.1° — 90°).

As far as we know, the only other investigator who has analyzed his results statistically is Athayde ('32). We were unable to secure a copy of his paper but, according to a review of it, his results are inconclusive as his correlation coefficients are slight, negative and differ on the right and left sides.

Lambert (1892, p. 243) reported that the short humeri have a greater torsion than the long ones, a finding we cannot confirm. In our material of the white race the left humerus of a pair is the shorter one in 73% of the males and 90% of the females, yet in both sexes the right humerus has a significantly greater torsion. When the length of the individual humeri is plotted against the torsion angle we do not find the correlation reported by Lambert.

Lambert also measured the thickness of the humerus at the level of the "deltoid V" and concluded that thickness is inversely proportional to the torsion angle. It is difficult to tell from his paper how many humeri he measured but when we plotted the torsion angles of 137 humeri against their thickness at the level of the "deltoid V" we found no evident correlation between the two characters.

One of the fundamental problems of humeral torsion which has received scant attention in the literature is the direction in which the

torsion has occurred. Gegenbaur (1868) believed it occurred in a lateral direction while LeDamany ('03) stated it was in a medial one. Howell ('39) has also noted that the humerus appears as though it had been twisted medially. None of these authors have discussed the matter thoroughly but some information on the subject is provided by the development of the fore-limb, the course taken by the nerves, and the relative strength and size of the scapulo-humeral muscles.

In the early stages of the human embryo the superior extremity is oriented in such a way that its extensor surface faces laterally, its flexor surface medially, and its preaxial border, i.e. the lateral condyle of the humerus and the thumb, cranially. A little later in development the entire extremity undergoes a 90° lateral rotation about its long axis so that the extensor surface faces dorsally (posteriorly), the flexor surface ventrally (anteriorly) and the preaxial border laterally.

This lateral rotation of the entire extremity would lead one to believe that the torsion of the humerus, which also occurs during ontogeny, though apparently somewhat later, has occurred in a lateral direction. Such, however, does not seem to have been the case.

In order to determine the effect of humeral torsion on the final or adult position of the lateral condyle, when the upper extremity is hanging freely at the side of the erect body, let us momentarily disregard the embryonic rotation of the entire limb. Consider also the starting position of the humerus to be that before rotation of the extremity occurs which means, in the freely hanging position of the limb, that the preaxial border of the humerus (i.e. the lateral condyle) would be directed forward or ventrally (anteriorly).

If, from the above starting position, torsion of the humerus had occurred through 164° (fig. 2 A), as Broca believed, the lateral condyle would be directed dorso-laterally or dorso-medially (posteriorly) in its final adult position depending on which direction the torsion had taken. On the other hand, if torsion has occurred through 74° (fig. 2 B), as we believe, the lateral condyle, in its final position, would be directed ventro-laterally or ventro-medially, depending on which direction the torsion had taken.

In addition, we must consider the effect of the 90° lateral rotation of the extremity on the adult position of the lateral condyle, although the time range in which each phenomenon (torsion and rotation) occurs undoubtedly overlaps to some extent. If it is assumed that the 164° of torsion found by Broca occurred in a lateral direction and there is added to it the 90° lateral rotation of the entire extremity, the lateral

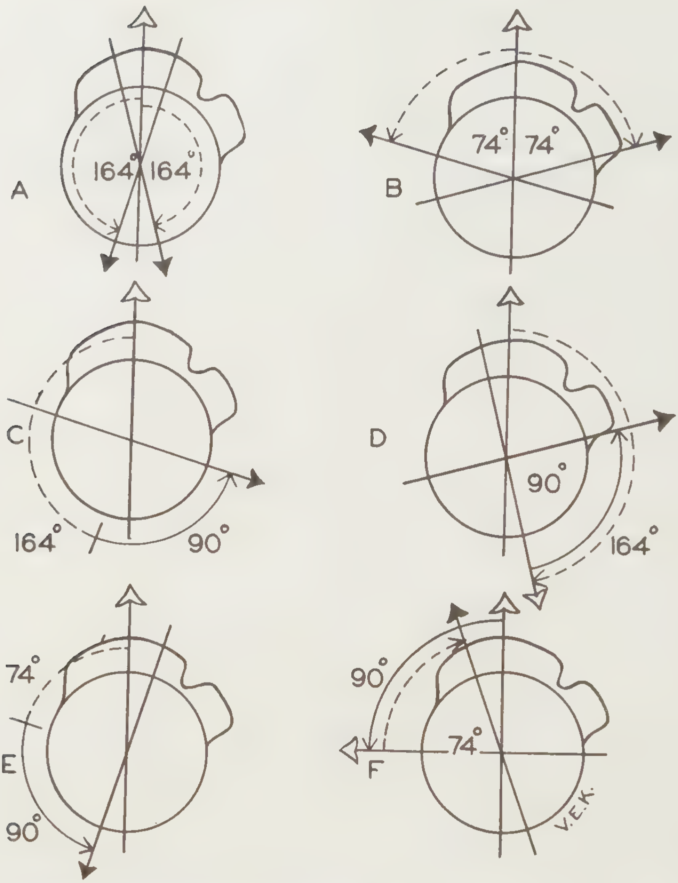

Fig. 2 Diagrams of a left humerus to illustrate the effect of torsion and rotation, according to various theories, on the position of the lateral condyle. In each case the starting position of the lateral condyle (indicated by an open arrow head), in the erect posture with a freely hanging limb, is assumed to be ventral or anterior as it would be in an embryo before rotation of the entire limb has occurred. The final adult position of the lateral condyle is indicated by a closed arrow head while the small arrows indicate the direction in which rotation (———) or torsion (- - - -) has occurred.

A. The effect of 164° of torsion, as found by Broca. The end position also depends on the direction of torsion.

B. The effect of 74° of torsion, as found by the authors. The end position also depends on the direction of torsion.

C. The effect of 164° of torsion in a lateral direction and the 90° lateral rotation which the entire limb undergoes during embryology.

D. The effect of 164° of torsion in a medial direction and 90° lateral rotation of the limb.

E. The effect of 74° of torsion in a lateral direction and the 90° lateral rotation of the limb.

F. The effect of 74° of torsion in a medial direction and the 90° lateral rotation of the limb which, according to the theory of the authors, accounts for the adult position of the lateral humeral condyle.

condyle of the humerus, in attaining its final adult position (fig. 2 C), would have moved laterally through an arc of 254° (164° lateral torsion + 90° lateral rotation) and, consequently, would be directed medially. If, however, the torsion had occurred in a medial direction it would have partially counteracted the 90° lateral rotation of the whole extremity and the lateral condyle, in attaining its final position (fig. 2 D), would have moved medially through an arc of 74° (164° medial torsion — 90° lateral rotation) and would be directed ventro-medially.

If it is assumed, from the same starting conditions as above, that the 74° of torsion found by us had occurred in a lateral direction the lateral condyle, in attaining its final position (fig. 2 E), would have moved laterally through an arc of 164° (74° lateral torsion + 90° lateral rotation) and, consequently, would be directed dorsally (posteriorly). This figure, 164°, is the same as Broca's average degree of torsion for the white race, and substantiates our belief that he included in his measurements the 90° rotation of the entire extremity. If, however, the 74° of torsion had occurred in a medial direction it would partially compensate for the 90° lateral rotation of the entire extremity and the lateral condyle, in its final position (fig. 2 F) would be directed ventro-laterally and would lie approximately 16° (90° lateral rotation — 74° medial torsion) laterally from its starting position. Allowing for the probable overlapping of the effects of torsion and of rotation, the last combination of events (i.e. a medial torsion and a lateral rotation) seems to best explain the ventro-laterally directed position of the lateral condyle of the humerus, seen in the adult human when the extremity is hanging freely at the side of the erect body with the palm facing medially.

Additional, less theoretical, evidence that torsion has occurred in a medial direction is supplied by the embryology of the superior extremity. According to Braus ('06, pp. 248–250) the torsion, which develops progressively in lower vertebrates (e.g. Lacerta), occurs almost from the beginning in man and the course of the radial nerve reveals the completed process. Braus also distinguished between a primary and a secondary pronation position of the forearm and hand. The primary position is the result of a torsion in the extremity shaft while the secondary position, which involves a crossing of the forearm bones, arises from a ventro-lateral movement of the radius head about the proximal end of the ulna. The latter movement is entirely independent of the torsion of the humerus. In his later work ('29, v. 1, p. 279, fig. 141, C and D) Braus plainly illustrates a medial torsion of the human

humerus and states (p. 282) as further evidence, that "The screw-like course of the radial nerve around the humerus in a spiral groove of the bone has the same direction as the described torsion of the humerus. In the right humerus both are left winding, in the left humerus right winding as in screw threads (left and right screw threads)."

An objection frequently advanced against humeral torsion is why, if torsion is a fact, do not all the nerves of the arm follow a spiral course instead of just the radial nerve. In reality, some of them do. For example, (Grant, '44, 3rd ed., p. 106, fig. 80) the posterior cutaneous nerve of the arm, the medial brachial cutaneous nerve, and the intercostobrachial nerve all, in order to reach the area they innervate, gradually spiral around the arm from the medial to the dorsal side.

Embryology also provides an answer to the above objection. Lewis ('02, p. 155), in a 4½-week-old (9 mm.) human embryo, found that the brachial plexus passed laterally into the arm where it split into its dorsal and ventral divisions. The dorsal division, corresponding to the radial nerve, passed around to the dorsal side of the humerus where it ended in the premuscle sheath near the distal end of the bone. According to Braus ('29, v. 1, p. 282), in all tetrapods the nerves passing caudally from the limb girdle have to pass along the limb from behind and hence must lie diagonally to the limb in order to reach its anterior border. Consequently, the radial nerve has this position from the beginning, long before any torsion occurs. However, Braus believes that the nerve is subsequently more powerfully twisted by the torsion of the humerus. Keith ('33, p. 489) admits a spiral twist to the humerus but doubts that it is in any way caused by the torsion which the limb undergoes.

The reason for the spiral course of the radial and other nerves to the extensor (dorsal) side of the arm becomes apparent when it is remembered that the entire brachial plexus is formed from the ventral (anterior) primary rami of the spinal nerves and that all the nerves derived from the plexus enter the arm ventral (anterior) to the humerus. Consequently, the nerves supplying the musculature (radial nerve) and the skin (medial brachial and posterior brachial cutaneous nerves) on the dorsal (extensor) surface of the arm must take a spiral course around the humerus in order to reach their destination. However, the nerves innervating the ventral (flexor) surface of the arm are already in a ventral position and hence do not need to spiral around the humerus.

The marked caudal inclination of the branchial plexus in the adult is caused by the caudal migration of the superior extremity during the

sixth week of embryonic life (Lewis, '02, p. 169). However, the effect of humeral torsion on the course of the nerves can still be demonstrated in the human cadaver. Thus, a 90° abduction of the superior extremity tenses the radial nerve while the nerves to the ventral (flexor) surface of the arm remain quite slack. If the arm is then adducted and rotated medially, the nerves arising from the ventral (anterior) division of the brachial plexus become more slack while the tension on the radial nerve is maintained. Thus, it is evident that the original spiral course of the radial nerve would be further increased by a medial torsion of the humerus while the ventral nerves would be little effected.

Some recent work by Inman, Saunders and Abbott ('44) also furnishes evidence supporting the belief that torsion has occurred in a medial direction. Data from their figures for the mass of the scapulo-humeral musculature in a series of recent mammals show that the medial rotator muscles are larger than the lateral humeral rotators. Thus in man the medial rotator muscles (subscapularis and teres major) constitute approximately 31% of the total mass of the scapulo-humeral musculature while the lateral rotators (supraspinatus, infraspinatus and teres minor) only form about 26.5% of the total mass. The deltoid has been omitted from the present discussion because it may act as either a lateral or a medial rotator.

Since it is generally believed that a rather direct relationship exists between the size and the strength of a muscle, the conclusion is that the medial rotator muscles, because of their greater size, are a stronger muscle group than the lateral rotators and therefore have a greater influence on humeral torsion. The result of this would be a medial torsion of the humerus.

Inman et al. are not concerned with humeral torsion and only mention it briefly. However, one of their figures (p. 6) clearly shows a medial torsion and their statement that "The effect of torsion has been to displace the bicipital groove medially, so that it encroaches upon, and reduces the size of the lesser tubercle" is additional evidence favoring a medial torsion.

The site of torsion has also been the subject of some speculation, C. P. Martin ('33) considering it to be in the surgical neck of the humerus while LeDamany ('03), Krause (1899), and Rouffiac ('24) believe it is in the proximal epiphyseal cartilage. However, the evidence for both sites is inconclusive. We are inclined to believe that the site of torsion is probably in the region of the proximal epiphyseal cartilage because, before ossification is completed, this is an area of considerable plas-

ticity. Furthermore, in man the proximal epiphysis does not fuse with the diaphysis of the humerus until quite late in life (18 to 20 years) which means that the muscular and other forces responsible for ontogenetic torsion have a relatively long time in which to produce their effect.

SUMMARY AND CONCLUSIONS

1. Measurements of the degree of torsion were made on 276 adult humeri of eighty-nine white and forty-nine American Negro individuals.

2. The measurements were made with a recently designed instrument, the Torsiometer.

3. In view of the previous confusion of terms by various authors, the distinction between humeral torsion and the rotation which the entire fore-limb undergoes during ontogeny has been emphasized and discussed.

4. Humeral torsion is apparently the result of the interaction of a primary (hereditary) torsion upon which is superimposed a secondary (ontogenetic) torsion probably produced by function, muscular traction, etc.

5. In the white race the mean humeral torsion and the mean torsion for the right humerus are significantly greater than in American Negroes. The mean humeral torsion is significantly greater in the right humerus among members of the white race but there is no significant difference between the sides in American Negroes. In American Negroes humeral torsion is significantly greater in females but in the white race there is no significant sexual difference in humeral torsion. The mean humeral torsion in males of the white race is significantly greater than that in American Negro males but there is no significant difference between the mean torsion in the females of the two races.

6. The range of varition in humeral torsion is approximately the same in both races but white females exhibit a greater range of variation than do the males.

7. In adult individuals there is no apparent correlation between age and the degree of torsion of the humerus.

8. When torsion was studied with respect to humeral length and thickness at the level of the proximal epiphyseal line the following relationships were found. When the members of a pair of humeri differ in length the greater torsion more frequently (63% white race; 56% American Negroes) occurs in the longer humerus of a pair. When the members of a pair of humeri differ in thickness the greater torsion more often (68%) occurs in the thicker bone in the white race and in the

thinner bone (74%) in American Negroes. In both races the right humerus is generally the longer (83% white race; 77% American Negroes) and thicker (73% white race; 66% American Negroes) member of a pair.

9. The average degree of torsion is 74.4° for the white race and 72.6° for American Negroes.

10. Data from the work of Wermel and of Jones indicate that function (handedness in the case of man) is probably an important ontogenetic factor influencing humeral torsion.

11. Evidence from osteology, embryology, myology and the course of the nerves of the arm indicates that humeral torsion has occurred in a medial direction.

12. The maximal degree of torsion is found in the white race and is less than 90° instead of approximately 180° as believed by some authors.

13. The region of the proximal epiphyseal line seems to be the most probable site of humeral torsion although the evidence is incomplete.

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TORSION OF THE LOWER EXTREMITY

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TWO FIGURES

The lower extremity of man performs its major movements in a plane which is roughly parallel to the median plane of the body. The ankle joint, the knee joint, and the neck of the femur might consequently be expected to be oriented with their axes in transverse position and parallel to each other. This expectation is not realized. When viewed from above, with the limb in a vertical position, the neck of the femur makes an angle with the axis of the knee joint and the axis of the ankle joint is not parallel to that of the knee joint. On the assumption that the discordance in orientation of the femoral neck with respect to the knee joint was produced by a twisting of the shaft of the femur, it has received the name of femoral torsion. Tibial torsion has been similarly used to designate the deviation of the ankle joint axis with respect to the proximal end of the tibia.

The torsions of the femur and of the tibia have been extensively measured as attributes of the separate bones, a procedure which has proven of some value in comparative anthropometry. A functional significance of these measurements has been suggested by Mollier ('38), who was especially impressed by the effect which extreme tibial torsion would have on the alignment of the foot. He thought that individuals with large angles of tibial torsion compensated for this by rotating the femur inward and attributed to this supposed rotation certain characteristic aberrations in walking. Lanz and Wachsmuth ('38), in their excellent treatise on the anatomy of the lower extremity, have considered the torsions of the femur and the tibia on the basis of measurements gathered from the literature, with emphasis on their variability.

Since both femoral torsion and tibial torsion affect the mechanism of the lower extremity, it is of value to know whether the extensive variations displayed by the femur and by the tibia are independent or are correlated. Measurement of femoral torsion is exceedingly difficult in the living, although Stewart and Karshner ('26) and Rogers ('31, '34) have developed approximate radiographic methods. The next best

source of material is the cadaver; the measurements here reported were obtained from the right lower extremities of thirty-five male cadavers.

METHOD OF MEASUREMENT

The measurements were made after disarticulating the hip joint, laying bare the articular cartilage of the posterior aspect of the femoral condyles, and arranging the lower extremity on a level table with the posterior borders of the femoral condyles touching the table. The knee was in complete extension and the sole of the foot perpendicular to the table. The plane of the table was consequently parallel to the frontal plane of the lower extremity. The reason for using the posterior surfaces of the femoral condyles is that they give a serviceable approximation to the orientation of the transverse axis of the knee.

The angles of torsion were measured in a plane perpendicular to the long axis of the lower extremity, which passes through the center of the head of the femur and the center of the talo-crural articulation. Except in pronounced cases of genu valgum or genu varum, this plane deviates but slightly from the infra-condylar plane. The advantage of using the long axis of the lower extremity for orientation lies in its intimate correlation with function; it corresponds to the ''line of weight-bearing'' of the orthopaedic literature.

The angles which were measured are illustrated in figure 1. They are three in number: (1) Torsion of the neck of the femur with respect to the frontal plane; (2) Torsion of the malleolar line with respect to the frontal plane; and (3) Deviation of the medial border of the foot with respect to the sagittal plane. In all cases the measurements are in degrees and clockwise rotation in the right extremity as viewed from above is regarded as positive.

The measurement of the torsion of the femur is limited in accuracy by the difficulty of locating the mechanical axis of the neck. This axis has actually only been located once, by Koch ('17), during an investigation of the bony architecture of the femur. In the measurement of femoral torsion various methods of approximation have been employed, but none have been entirely satisfactory. Measurement on the cadaver has been found to be most satisfactory when accomplished by an indirect method. Advantage was taken of the antero-posterior flattening of the neck of the femur. The intersection of the superior border of the neck and a plane bisecting the neck in the direction of its longer diameter can be relatively accurately marked and its inclination to the frontal plane determined. The correction to be applied to this reading to convert it

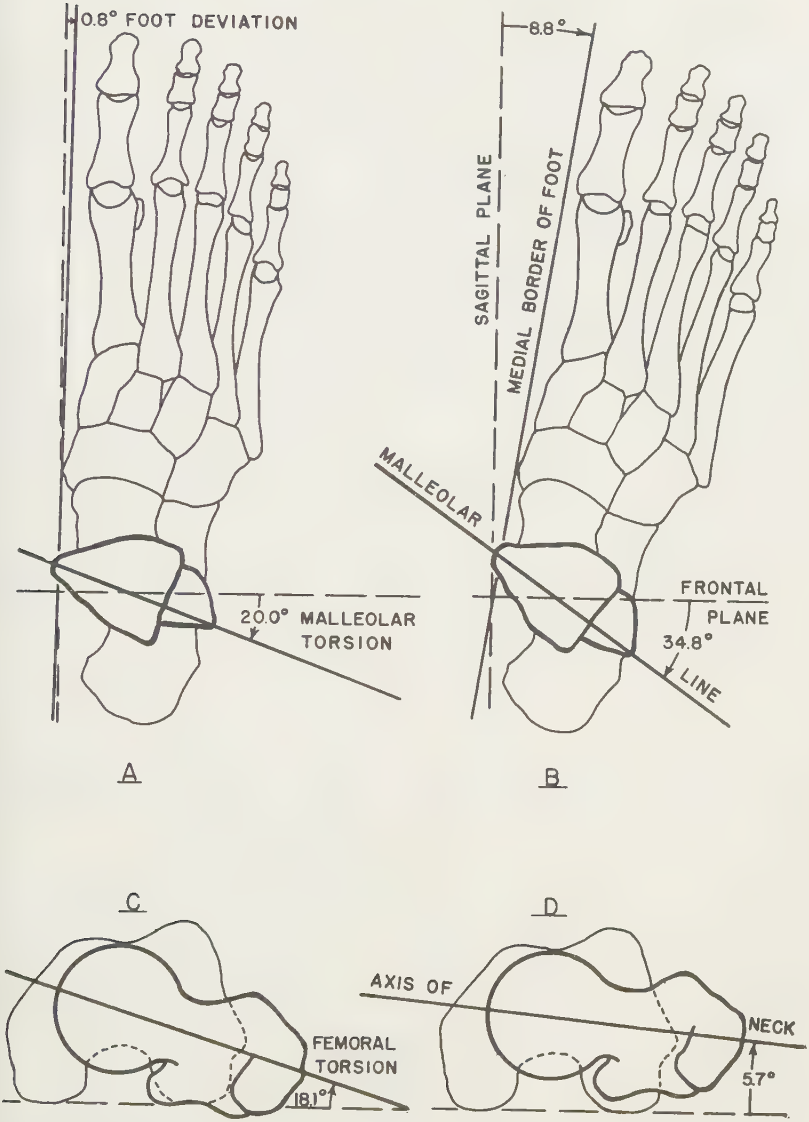

Fig. 1 Variation in torsion of lower extremity of adults.

A. Malleolar torsion of mean less standard deviation, with mean foot deviation associated th it.

B. Malleolar torsion of mean plus standard deviation, with mean foot deviation associated th it.

C. Femoral torsion of mean plus standard deviation.

D. Femoral torsion of mean less standard deviation.

Since femoral torsion and malleolar torsion are independent, A and B have equal likelihood being associated with either C or D.

into true femoral torsion is determined by the slope of the bisecting plane.

The angle of malleolar torsion was measured with the knee in full extension, allowing the use of the frontal plane previously described for the orientation of the proximal end of the tibia. This is more satisfactory, from the point of view of function, than attempting to orient the tibia by means of an evaluation of the articular facets. The distal transverse axis of the tibia should properly be the axis of the talocrural joint. In this investigation, the malleolar line was used, both internal and external malleoli being bisected, the points marked with pins, and the angle with the frontal plane measured. This angle we shall call malleolar torsion, to distinguish it from the measurements of tibial torsion based on a bisection of the distal articular surface of the tibia. The advantage of using the malleolar line lies in the fact that it can be determined in the living and has been used in studies of the foot. In general, malleolar torsion exceeds tibial torsion by about 5 degrees.

The third angle measured was the deviation of the foot. This was determined by adjusting the ankle so that the sole of the foot was perpendicular to the frontal plane and then reading the angle made by the median border of the foot with the sagittal plane.

MEASUREMENTS

Table 1 gives the values in degrees of the angles of femoral torsion, malleolar torsion, and foot deviation for the right lower extremities of thirty-five male cadavers. All angles encountered were positive. The arrangement is in order of increasing malleolar torsion.

The average femoral torsion, with its standard error, is 11.86 ± 1.05. This is in accord with the values which have been recorded in the literature from the measurements of dry bones. Mikulicz (1878) presented measurements on 120 femurs of undesignated sex, from which I have computed a mean of 11.67 ± 0.88. Le Damany ('03) studied fifteen femurs from each side, obtaining a mean of 11.33 for the right and 14.07 for the left. Pearson and Bell ('19), in their very extensive series of seventeenth century bones, found average values of 11.63 for the right and 14.71 for the left femurs which they judged to be male. Their figures for "females" were somewhat higher. Ingalls ('24), working with more desirable material, 100 femurs from each side of modern male whites, determined an average of 11.76 for the right and 9.73 for the left. The rough average of 12 degrees which is used clinically consequently seems well substantiated.

Of great practical importance is the variability displayed by the torsion of the femur. It is best indicated by the standard deviation, which is 6.21 ± 0.74 for the present series. In figure 1 (C and D) are illustrated two femurs with femoral torsions greater and less than the mean by the amount of the standard deviation. Ingalls ('24) found a standard deviation of 7.87 for the right femur of the male while Pearson and Bell ('19) give a somewhat higher value, 8.80. From the data of Mikulicz (1878), I have computed a standard deviation of 9.61.

TABLE 1

FEMORAL TORSION	MALLEOLAR TORSION	FOOT DEVIATION	FEMORAL TORSION	MALLEOLAR TORSION	FOOT DEVIATION
2	12	0	15	27	4
0	14	0	6	27	0
11	17	0	10	29	8
14	17	0	10	29	9
12	20	0	3	31	4
13	20	0	7	32	16
4	22	8	3	33	14
14	23	0	10	33	7
26	23	3	15	33	8
21	23	0	18	33	7
8	23	0	19	33	8
11	24	8	25	34	5
18	24	5	13	35	0
15	25	0	13	36	7
4	25	0	14	40	7
17	25	0	13	42	16
15	25	0	13	44	10
3	26	8			

The average malleolar torsion measured on the present series is 27.40 ± 1.25. Le Damany ('09), measuring 100 pairs of bones, found the average tibial torsion of the right to be 23.68 and of the left 20.06. These results are in good agreement, when it is remembered that malleolar torsion values tend to be about 5 degrees larger than values for tibial torsion. The measurements of Mikulicz (1878) yield an average of 15.71.

The variability of the torsion of the tibia is similar in magnitude to that of the femur; it is illustrated in figure 1 (A and B). The standard deviation for the present series of malleolar torsion measurements is 7.40 ± 0.89. For the series of Mikulicz it is 8.99 and for that of Le Damany 10.27 for the right and 10.09 for the left.

The average angle of foot deviations is 4.6 ± 0.8, with a standard deviation of 4.8. This measurement is necessarily approximate in the cadaver. It is related to the "angle of gait", with which it coincides if

the transverse axis of the knee joint is actually in a frontal plane during locomotion. Dougan ('24) measured the angle of gait of 126 male college students, using a median line through their imprints as his foot axis, and found an average of 7.36 for the right foot and 6.22 for the left. Patek ('26) made similar measurements for 150 college women, the average for the right foot being 6.5 and for the left 7.0. Morton ('32) reported measurements on Central African natives, using a line through the middle of the heel and the first interspace. The average for eighty-seven men was 8.3 for the right and 7.9 for the left foot. These values for angle of gait cannot, of course, be rigorously compared with the angle of foot deviation, but the similarity is at least suggestive.

CORRELATION BETWEEN MALLEOLAR TORSION AND FOOT DEVIATION

Since the angle of foot deviation measures the angle which the inner border of the foot makes with the sagittal plane, it is to be expected that this angle will increase with increase of malleolar torsion. This is verified by the measurements here presented. The correlation coefficient is +0.666. The equation of a line fitted to the data by the method of least squares gives the following relationship:

$$\text{Foot deviation} = 0.54 \text{ malleolar torsion} - 10.03$$

The fact that the deviation of the foot increases more slowly than does the malleolar torsion may be a matter of some significance. The malleolar line is intimately connected with the trochlea of the talus; the orientation of the talus is, in turn, of the utmost importance in determining the configuration of the foot. This is largely due to the participation of the talus in both the sub-talar and transverse tarsal joints.

CORRELATION BETWEEN FEMORAL TORSION AND MALLEOLAR TORSION

Extreme degrees of either positive or negative femoral torsion are known to influence the positions assumed by the lower extremity during use. It might consequently be supposed that some degree of association would exist between femoral torsion and malleolar or tibial torsion. When the correlation coefficient is computed for the present series of measurements, it is found to be +0.225, showing it to be of doubtful significance. The correlation coefficient of femoral torsion and tibial torsion computed from Mikulicz' (1878) series of 120 measurements is −0.023. From these results, obtained from two different series of material, by two different methods, it would seem safe to conclude that in the adult there is no significant correlation between femoral torsion and malleolar or tibial torsion. It appears to be more likely that a corre-

lation may be found between femoral torsion and the characteristics of the pelvis. The tendency in the past to assume a correlation between femoral and tibial torsion was doubtless due to a misinterpretation of the changes taking place in the femur and the tibia during fetal development.

DEVELOPMENTAL CHANGES IN FEMORAL TORSION

The changes which femoral and tibial torsion undergo with age are summarized graphically in figure 2. The largest series of fetal measurements has been made by Altmann ('24). The youngest embryos show definitely negative values of femoral torsion; for an embryo of a total length of 17 mm. the values were —10 and —11. With further development, the neck of the femur rotates with respect to the condyles until the average position of the axis of the neck is parallel to the condylar axis when the crown-rump length reaches 60 mm. Consequently during

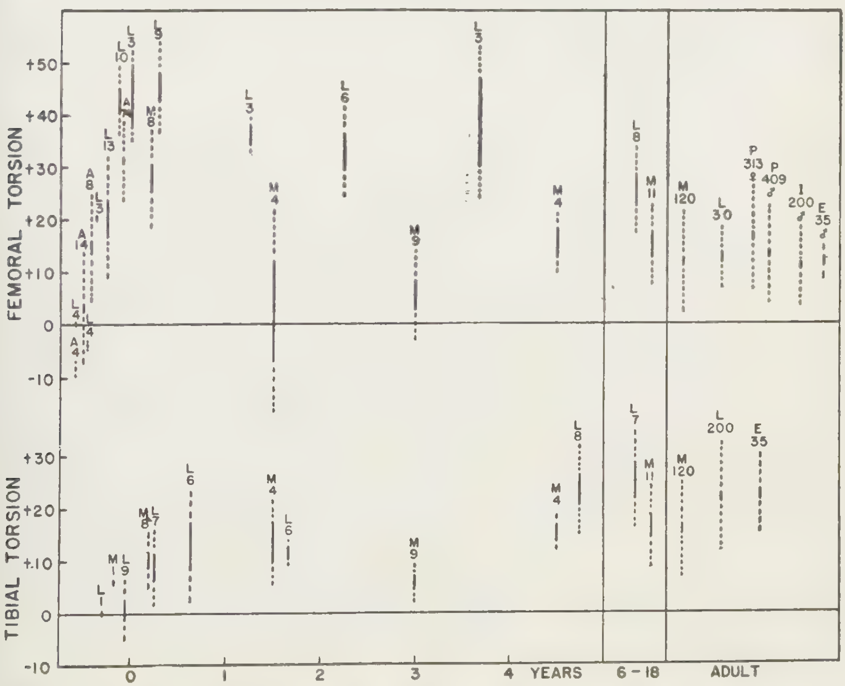

Fig. 2 Changes of femoral and tibial torsion with age. Solid lines — mean ± S.E. Dotted lines — standard deviation. Number above each line indicates the size of the sample and the letter is the initial of the investigator: Altmann ('24), Elftman (present paper), Ingalls ('24), Le Damany ('03, '09), Mikulicz (1878), and Pearson and Bell ('19).

the third month of development the previously negative femoral torsion becomes zero, to be followed by increasingly larger positive angles. The adult average of 12 degrees is reached shortly after the completion of 4 months of development. The fetus, however, has no regard for this attainment of the adult value; the femoral torsion continues its steady increase. In a series of seventy-four late fetuses, Altmann found an average femoral torsion of +31; Le Damany ('03) obtained even higher values.

There can be little doubt that the torsion which the femur undergoes during development is more directly concerned with the disposition of the fetus in the uterus than it is with the speedy attainment of an adult configuration. Even if we cannot specify the developmental factors involved, we can note the correlation between the changes in femoral torsion and the successive positions assumed by the lower extremity during fetal life.

The data of Altmann ('24) show an essentially linear relationship between femoral torsion and crown-rump length for lengths less than 150 mm., the latest stage for which he gives detailed measurements. The relationship is the following:

$$\text{Femoral torsion} = 0.2 \ (\text{CR length in mm.} - 60)$$

It is important to note that even at this early stage, the torsion of the femur shows great individual variation, the standard deviation of Altmann's data, when computed with respect to the above equation, being 9.6. By coincidence, this is exactly the standard deviation of Mikulicz' adult femurs.

Since the newborn enters the world with a high degree of positive femoral torsion, a marked decrease must take place before the adult condition is reached. Unfortunately, adequate data are not available for the early formative years. From figure 2 it is apparent that there is a wide divergence between the measurements of Le Damany ('03) and Mikulicz (1878). There is no technical reason for preferring one series of measurements over the other. If Mikulicz is correct, the detorsion of the femur takes place chiefly in the first 2 years. This would suggest an association with walking. Le Damany also records a decrease in the first 2 years, but this is not sufficient to bring the femoral neck near its acknowledged adult position. Further measurements are needed to solve this problem.

DEVELOPMENTAL CHANGES IN TIBIAL TORSION

The tibia also changes its degree of torsion during prenatal life, but our information concerning the tibia is less complete than it is for the

femur. Le Damany ('09) found no torsion in a 6 months fetus; even at 9 months there was, on the average, less than one degree of positive torsion. According to both Mikulicz and Le Damany, there is a rapid increase in tibial torsion during the first year of postnatal life, definitely before attempts at walking are first made. The data shown in figure 2 certainly do not show any marked changes during the second year. It is unfortunate that our information for the important early years is so utterly insufficient. Le Damany ('09) concluded that the adult degree of tibial torsion was established by the fifth year. This conclusion has been widely quoted. Although it is true that Le Damany's measurements of eight individuals in the 4- to 5-year range yield an average of +23.1, the measurements of Mikulicz show lower values. It may very well be that Le Damany was right and tibial torsion does become stabilized by the age of five; but this conclusion is certainly not, as yet, supported by adequate measurement.

MECHANISM OF CHANGE IN TORSION

Numerous attempts have been made to attribute the progressive changes in femoral and tibial torsion to forces which are extrinsic to the developmental capacities of the femur and tibia themselves. That bones do respond to external forces by changes in shape and internal architecture has long since been proven beyond the necessity of further confirmation. Among the experiments which support this statement are those which Le Damany ('09) performed on the rabbit. By dislocation of the hip, he was able to produce not only changes in the femur but also astounding changes in the angle of tibial torsion.

It has been a popular pastime with previous investigators of femoral and tibial torsion to single out all the forces which could conceivably produce the observed changes and attribute to them, without experimental confirmation, the rôle of developmental factors. Among the factors so invoked have been pressure of the uterine wall, pull of the external rotators of the femur, increased function of the gluteus maximus, support of the weight of the body in walking, and the weight of the extremity itself during the first year of life.

Attractive as some of these theories may appear at first glance, when analyzed carefully they become less convincing. Surely if one external force is considered, the others which are acting simultaneously must also be taken into account. As an example, the effect of walking on the femur and tibia cannot be evaluated by considering only the external rotators of the hip; the other muscular, gravitational and effective forces must also be considered. This has not been done. It may be

feasible in the future, by applying the methods of Elftman ('39) to three-dimensional data concerning human movement.

When the external forces have been properly evaluated, it is then necessary to determine the internal stresses in the particular bone involved. This has been done for the femur by Koch ('17), for the simplified situation of weight-bearing.

The final factor which must be evaluated is the innate capacity of the bones themselves to respond to the external forces or to proceed counter to them. The self-differentiating capacity of the femur, as demonstrated by Fell ('29), should have a sobering effect on anyone who expects to find a simple solution for the intricacies of development in a consideration of external forces.

More direct methods of experimentation would be advantageous, if possible of performance. Since the problem of femoral and tibial torsion is essentially a human problem, we are largely limited to the experiments which nature performs for us. Altmann ('24) records three cases of spina bifida sacralis and one of spina bifida lumbo-sacralis and notes that the paralysis of the external rotators had not interfered with the usual femoral torsion. Analysis of clinical conditions, such as rickets, also throws some light on the problem.

SUMMARY

The torsion of the femur of the adult varies independently of the torsion of the tibia; it is consequently impossible to predict one from the other. The angle of foot deviation increases with the torsion of the tibia, but more slowly. The relative orientation of the neck of the femur and of the axes of the knee and ankle joints is of importance in locomotion and in foot mechanics.

The progressive increase in both femoral and tibial torsion during fetal life is well established. The femoral torsion at birth is much greater than it is in the adult, while the torsion of the tibia is smaller than the adult value. The ages at which the adult conditions of torsion are reached have not yet been accurately determined, and the factors which influence the changes in torsion await adequate evaluation.

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REVISED RECONSTRUCTION OF THE SKULL OF PLESIANTHROPUS TRANSVAALENSIS BROOM

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THREE PLATES

In this Journal, vol. 26, for March, 1940, we described our reconstruction of the dental arches of Plesianthropus transvaalensis Broom and our first tentative reconstruction of the skull. Since then Dr. Broom has very kindly sent us several photographs, sketches and detailed casts, as well as a copy of his reconstruction of the skull, which give us better information and enable us to correct several errors in our first model and in the unpublished second model. Dr. Broom has described his material in shorter articles and especially in a fuller memoir which may be already published, although we have not yet received a copy. But as there is no question as to his priority of discovery and as he has generously encouraged our use of his material, we venture to submit the following brief supplement to our previous reports.

After carefully reviewing the data relating to the upper canine, we find no reason as yet to change our previous reconstruction of the crown of that tooth, which is missing on both sides in the type maxilla but is well preserved in the cotype. In the latter only the tip of the small crown is worn off but the shape and dimensions are remarkably human and its crown is in contact with that of the small lateral incisor. The facets of these teeth indicate an edge-to-edge bite, while the relatively flat crowns of the molar teeth (as compared with those of anthropoids) also indicate a somewhat rotary way of chewing, as in man. In the type maxilla the position and size of the roots of the canine, lateral incisor and first premolar, as well as the narrowness of the bone between the sockets of the canine and lateral incisor, all suggest to us that at least in this specimen the canine crown was not protruding and tusk-like as in male anthropoids, but short and at least subhuman in shape, and that its crown was in contact with the lateral incisor.

In Dr. Broom's restoration of the skull and dentition he has modelled an upper canine tooth to fit the missing crown of the type; but instead of following the form of the well preserved but smaller upper canine

of the cotype, he has modelled a new crown, which we have compared carefully with those of various anthropoids. As a result of this study we are compelled to offer the foregoing criticisms of Dr. Broom's model of this tooth.

For our reconstruction of the upper dental arch we were courteously given direct access to the material by Dr. Broom on the occasion of our visit to South Africa in 1938. The casts and measurements that we obtained then, from which we reconstructed the palatal arch, seem to leave little room for doubt as to the essential correctness of our reconstruction, in which the palatal arch was much narrower across the canines than it was across the second molars.

In our first tentative reconstruction of the bony face we assumed that a certain concavo-convex piece of bone that was in the matrix of the type, beneath the glabellar region, was the displaced nasal bone. After Dr. Broom had removed this bone from the matrix, he decided that this bone was part of the frontal part of the maxilla, and since it also shows part of the lacrymal rim of the orbit, we have so placed it in the present reconstruction. The orbital rim of the frontal gives us much of the dorsal contour of the orbit, while the preserved part of the malar restores the lower outer border, so that these pieces collectively permit a closer approach to the height, width and contour of the orbits.

In our first model the anterior nasal opening (apertura pyriformis) appeared to be unduly small and the same was true of the orbits. Moreover, the ascending rami of the mandible looked uncomfortably low for the general size of the skull. All these objections were met simultaneously by pushing the upper dental arch forward and downward a little, so as to increase the total face height by about 6 mm. This also served to accomodate better the large malar bones, of which the right malar is indicated as fairly well preserved in Dr. Broom's reconstruction. This moderate forward-and-downward shifting of the palatal arch also gave more room for the parts behind the pterygoid fossae, which appeared to be crowded in our first model.

The top of the skull in our first model was built up upon the braincast and upon the cast showing the supraorbital tori, both frontal sinuses and the imprint of the frontal lobes of the brain. Later data tends to confirm this, at least in the main.

By far the greatest apparent error of our first model lay in the narrowness across the occiput. This was pointed out to us by Dr. Broom, who sent us sketches of the base of the cranium, which was not exposed at the time of our visit to South Africa. His model of the skull also

indicates as present most of the left, and part of the right occipital region, together with the root of the right zygoma. As now restored, the width across the squamous region above the mastoids is 135 mm. This great width, however, has not much changed the cephalic index, the width in the latter being across the parietal convexities.

The base of the skull and the position of the foramen magnum are but roughly indicated in our model and are more fully discussed by Dr. Broom.

The main comparative measurements of the present model are as follows:

	PLESIANTHROPUS (Our revised estimates)	PLESIANTHROPUS (Broom's model)	GORILLA ♂	GORILLA ♀	CHIMPANZEE ♂	CHIMPANZEE ♀	HEIDELBERG (CAST)	RHODESIAN (CAST)	AUSTRALIAN ABORIGINAL
Head length (l)	141	137	158	141	139	126		209.0	180.1
Head width across parietals (w)	107	97	103	94	94	93		147	126.3
Index $\frac{w \times 100}{l}$	76	70.0	65.2	66.7	67.6	73.8		70.3	70.1
Minimum frontal	83	69	69	66	73	67		104.6	91.9
Width above mastoids	135	128	140	124	105	113		151	
Auricular height (h)	71e	62	75	65	70	68		110	112.1
Index $\frac{h \times 100}{l}$	50.0	45.3	47.5	46.1	50.4	54.0		52.6	62.2
Total face height (fh)	126	123	160	140	111	117		...	108.3
Bizygomatic width (zw)	140	132e	172	139	122	120		149	128.9
Index $\frac{fh \times 100}{zw}$	90.0	93.2	93.0	100.7	90.0	97.5			84.0
Upper face height (ufh)	84	81	112	98	70	84		94	65.8
Index $\frac{ufh \times 100}{zw}$	60.0	61.4	65.1	70.5	57.4 [3]	70.0		63.1	51.0
Facial angle [1]	70°	64°	42°	62°	62°	63°		87°	78.6°
Alveolar angle [2]	53°	44°	35°	48°	46°	57°		74°	52.3°
Mandible, corpus length (cpl)	109	109	144	121	87	90	101.0		80.1
Mandible, condylar height (cdh)	74	102	104	87	64	70	67.5		63.6
Index $\frac{cdh \times 100}{cpl}$	68	93	72.2	71.9	73.6	77.8	66.8		79.8
Mandible, bicondylar width (bcw)	126	131	142	117	94	104	132.0		110.9
Mandibular angle (gonion)	108°	90°	98°	100°	111°	103°	107°		113.9°
Mental angle	110°	108°	108°	110°	131°		97.5°		77.3°

[1] Angle between the horizontal, parallel to Frankfort plane, and line from prosthion to nasion.

[2] Angle between the horizontal, parallel to Frankfort plane, and line from prosthion to infranasale.

[3] Exceptionally small upper face.

From these data it will be seen that the main points in which our revised model differs from Broom's are: (1) greater width across parietals; (2) greater minimum frontal width; (3) greater auricular height; (4) greater facial and alveolar angles; (5) markedly less condylar height; (6) decidedly greater mandibular angle. In most respects our figures happen to lie between anthropoid and human limits; Broom's lie chiefly within the anthropoids and some fall below; his condylar height in relation to corpus length is much higher than in either anthropoids or man; his mandibular angle is decidedly less than in either anthropoids or man.

PLATE 1

EXPLANATION OF FIGURES

Norma lateralis.

Facial contours in general intermediate between typical anthropoid and lower human stages. Canines relatively small; molars very large, increasing in anteroposterior dimensions posteriorly. Malar-zygomatic construction robust but subhuman. Auricular height within the anthropoid range.

All figures one-half natural size.

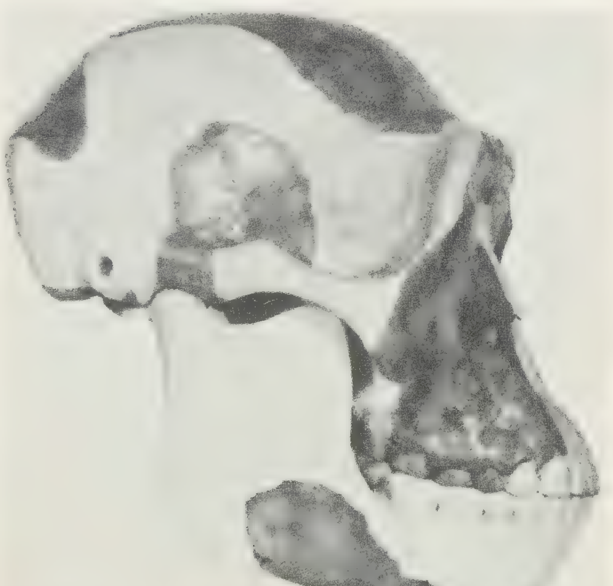

PLATE 2

EXPLANATION OF FIGURES

A, Norma frontialis. B, Oblique anterior view.

A Front teeth restored from cotype, showing man-like small canine, lack of diastema, moderate size of central and lateral incisors, edge-to-edge bite. Orbits and nasal aperture moderate in size.

B Occlusion of teeth completely man-like, including relations of upper and lower canines and premolars. Malars with strong masseteric tuberosity. Supramastoid swelling merging into occipital torus, as in some apes and earlier men.

PLATE 3

EXPLANATION OF FIGURES

A, Norma verticalis. B, Norma basalis.

A Prognathism moderate; width across malars and temporals intermediate between apes and man, but occipital protuberance very slight.

B The form of the anterior segment of the dental arch is here restored from the beautifully preserved but smaller cotype right maxilla, containing the alveolus of the central incisor, the entire lateral incisor, canine and first premolar, together with alveolus of p^2 and entire m^1. On the left side are present the alveoli of the canine and lateral incisor and part of the alveolus of the central incisor. The orientation of the opposite sides of the dental arches is discussed in our previous paper ('40, pp. 212–218).

PLATE 3

SKELETAL REMAINS FROM PRINCE WILLIAM SOUND, ALASKA

(Concluded)

BRUNO OETTEKING

Museum of the American Indian, Heye Foundation, New York, and Columbia University (retired)

ONE PLATE (PLATE 7)

II. OSTEOLOGY

THE MATERIAL

The osteological material, i.e., the skeletal parts, deriving from the same localities in the Prince William Sound area as the crania, belong either to the latter, or consist of single stray bones. The sites of finding, as in the case of the crania, comprise the following localities: Palutat Cave, Palugwik Village, Palugwik East Point, Tauxtwik, Glacier Island, Hawkins Island.[14]

An accounting of the number of bones available for study is given in connection with the description of each part of the axial and appendicular skeleton.

GENERAL PROCEDURE

The incompleteness of the individual skeletons and the variable state of preservation proved a handicap for a more exhaustive and definitive investigation of the parts available, although fragments of long bones which lent themselves to metrical treatment have also been utilized. Ribs, for the reasons mentioned, were excluded from measuring, while on account of unpromising results within the limited scope of this investigation the study of the hand and foot bones remained also unconsidered.

An attempt toward a more correlative study of the skeletons in their entirety will be found in the chapters on the Final Mathematical Deductions (Indices of Skeletal Proportions, Stature Calculations).

Arithmetic and differential reductions of the metrical data except for a number of important measurements have not been attempted because of the paucity of osteological specimens. Instead, it seemed advisable, to list only the ranges, male and female, of absolute measurements and indices as well as those of the metrical differences between the bones of the right and left sides of the body. The metrical data are assembled in table 15.[15] The individual measurements not published here are available at the author's laboratory (Museum of the American Indian, Heye Foundation, New York).

[14] See footnote 4. Page 63, Am. J. Phys. Anthrop., vol. 3, no. 1, March, '45.

[15] As in part I (Craniology) the metrical symbols, (mm.) in the tables of measurements have been omitted in this section, part II (Osteology). See footnote to table 1, p. 64.

SPECIAL INVESTIGATION

The skeletal parts in the order as listed above are discussed from the morphological and metrical viewpoints, as follows:

Vertebral column

The morphological habitus of the few vertebrae available varies from delicateness as in P. C., D ♀ to massiveness as in P. C., C1 ♂. The cervical vertebrae are marked by deep and spacious sulci for the spinal nerves and unusually large foramina costotransversaria for the vertebral arteries. The frequency of bifidity of processus spinales of the cervical vertebrae could not be ascertained because of the impaired condition of the specimens.

Vertebral arthritis, judging from the few specimens on hand, seems to have been quite common in the lumbar vertebrae, although no excessive case of this osseous disease came under observation.

Os sacrum:

Morphological. As far as sex could be ascertained, their numbers amounted to four male and three female sacral bones. The specific sex characteristics are not too well pronounced, except in P. C., A ♂, whose pelvinar surface is strongly curved both longitudinally and transversely, and in P.C., B1 ♀, distinguished by marked flatness.

No anomalies except mergings of the last sacral with the first coccygeal vertebras in P. C.: A ♂, B3 ♀, and D ♀, were observed.

Metrical. Measurements, on account of the paucity of specimens and the uncertainty of sex, do not fully bear out the individual distinctions between male and female except in the two cases mentioned in the first paragraph where P. C., A ♂ and P. C., B1 ♀ attain sacral indices of 101.0 and 104.4 respectively. Both however fall into the subplatyhieric class of the index (100.0–105.9). The amount of concavity is more distinctly expressed in these two specimens, the midventral curvature index yielding 92.0 in the male and 97.4 in the female specimen.

The range of variation for the midventral straight length, according to Martin ('28, p. 1085), lies between the values 71–165 mm., that of the anterior straight breadth between 66–131 mm., and from this it will be noticed that our specimens hold well within the middle of these ranges.

In the same place Martin mentions that in all human varieties the female sacrum exceeds the male in breadth and that "the sex character of os sacrum . . . is more marked than the racial".

Thorax

Sternum:

Morphological. There are altogether six sterna, three males and three females. Corpora and manubria are separate in five of them, and one, P. V., Strat. III, Skel. I ♂, is represented by only its manubrium.

Perforation of the corpus was observed in only one specimen (P. C., B1 ♀) and an excrescence (calcification) was noted on the upper right angle of the manubrium (P. C., D ♀). Martin ('28, p. 1091), quoting ten Kate and Matiegka, gives a frequency of 13.3% of perforation in American Indians of various tribes, and of 6.9% in Europeans.

Metrical. In the absolute dimensions the female sterna range below the males. Martin ('28, p. 1090) states that also in relation to stature the male sterna exceed the female in length. In the corpus-manubrium length index our own averages of 47.2 and 56.4 in the sexes fairly coincide with Martin's of 46.2 and 54.3. The breadth-thickness index of the manubrium ranges from 21.1–32.8 in the males, and from 21.3–25.9 in the females; they likewise reflect the sex difference of capacity.

Costae:

The limited number and partly fragmentary condition of the ribs did not invite metrical study. From the descriptive angle their general status accounts for marked massiveness and a tendency toward roundishness. Only in the case of P. C., C2 ♂, the ribs may have been more slender. The female ribs rather share the general characteristic of robustness.

Shoulder girdle

Scapula:

Paired	(r + l)	♂1 = 2;	♀3 = 6
Single	r	♂ = 1;	♀ = 1
	Total	♂3;	♀7. Grand total 10

Morphological. In general appearance the scapulae are rather slender with no unusual distinctions except that in Gl. I., I and Txw. the incisurae scapulae are deep as against the shallow-to-medium status in the other specimens, and that in the Tauxtwik scapulae the fossae articulares possess deep incurvations in the upper halves of their ventral margins.

Metrical. The measurements show the male in every respect to exceed the female. This seems to be especially true of the morphological breadth and in connection therewith the morphological breadth of fossa infraspinata, but not so much that of fossa supraspinata.

The sparsity of our figures also reveals a decidedly shorter spina scapulae in the female. Size differences between right and left of the same individual vary somewhat as may be gained from the figures in table 15. In both principal dimensions fossa articularis is larger in the male while at the same time the right predominates over the left.

The scapular index reflecting more or less metrical differences in the sexes thus yields the higher indices to the females. For the same reason the breadth-height index of fossa articularis turns out higher in the males. The arithmetical mean for the scapular index (♂ + ♀) amounts to 63.3 on the right, and 63.2 on the left side; and for the fossa articularis index under the same premises to 68.9 (♂ 70.5, ♀ 67.8) and 67.9 (♂ 73.2, ♀ 64.4).

In the range of racial means for the scapular index as given by Martin ('28, p. 1096) and extending from 60–72, our two averages fall quite low, which is also the case for the fossa articularis index (p. 1097) where N.W. Indians are listed with 73.1 in the males and 71.4 in the females.

Clavicula:

Paired	(r + l)	♂4 = 8;	♀6 = 12
Single	r	♂ = 1;	♀ = 1
	Total	♂9;	♀13. Grand total 22

Morphological. Parson's ('16) statement that the left English clavicle exceeds the right in length seems to hold true also for the collar bones from Prince William Sound, where the rights range from 124–154 mm., the lefts from 124–157 mm. The sex difference falls unmistakably in favor of the males with ranges from 142–154 mm. and 142–157 mm. right and left against the females' 124–147 mm. and 124–144 mm. right and left. Quite convincing in regard to the greater length of the left bone is the list of differences (see table 15) where in the + left column the greater figures are assembled.

Metrical. The cross section index of the shaft exceeds the 100 mark in a number of male cases which is not in accord with the frequent statement of the greater sagittal diameter as against the smaller vertical. Most of the female bones yield indices of 100.0 in indication of the equality of the two measurements involved. The greater sagittal diameter however is revealed in the indices below 100.0 of which there are two in each sex, with an index as low as 72.7 in the P. E. P. 1 ♂ with vertical and sagittal diameters of 8 mm. and 11 mm. The averages of this index fall with 102.5 and 96.0 in the males and females where in each sex the right and left indices are identical.

Upper extremity

Humerus:

Paired	(r + l)	♂8 = 16;	♀4 = 8
Single	r	♂ = 2;	♀ = 2
	l	♂ = ..;	♀ = 1
	Total	♂18;	♀11. Grand total 29

Morphological. The humerus gives rise to a number of morphological distinctions, of which the more important ones are as follows: In general appearance the humerus is well-developed in either sex; it is particularly massive in P. C., C1 ♂; P. V., Strat. III, Skel. I ♂; P. E. P. III ♀. Strong deltoid tuberosities were seen in P.C., A ♂; P. C., C1 ♂; P. E. P. III ♀; Txw., Large Cave ♂. Good-sized medial epicondyles occur in P. C., D ♀, and in H. I. 414 ♂. The trochlear axis with reference to that of the shaft approximates the horizontal position, i.e., gives rise to a more obtuse condylodiaphysis (cubital) angle in: P. E. P., I ♂; P. E. P. II ♀; P. E. P. III ♂, and H. I ♂. The perforation of fossa olecrani was noticed in only one case: P. E. P. II ♀ (left).

Metrical. In our humeri the maximum length lies with a total range of 263–328 mm. nearer the lower extension of the world range of 260–380 mm. as given by Martin ('28, p. 1100). The male values exceed the female, and the right bones the left in the sexes which in both cases seems to be the typical condition. This is also revealed by the male and female length averages of 303.3 mm. and 277.6 mm., both sides combined. Separately in each side the averages attain 304.4 mm. and 301.9 mm. for the males of the right and left sides, and 281.5 mm. and 273.0 mm. for the females. According to the list of differences between right and left (table 15) these rise to 11 mm. all in favor of the males. The cross section index of the shaft ranges between 63.6 and 100.0 which latter value occurs in the females, right and left, while in the males they attain only 88.0 (r) and 96.7 (l). The cross section index of the caput extends in toto from 91.1–102.1 which morphologically indicates a tendency toward a circular cross section of the head of the humerus in the female, at least in our series, while that of the male remains ellipsoid throughout.

Radius:

Paired	(r + l)	♂5 = 10;	♀3 = 6
Single	r	♂ = 2;	♀ = 1
	l	♂ = 2;	♀ = 1
	Total	♂13;	♀8. Grand total 21

TABLE 15

Osteological measurements.

DENOMINATION AND NUMBER OF BONES MEASUREMENTS AND INDICES	RANGES OF ABSOLUTE MEASUREMENTS AND INDICES			METRICAL DIFFERENCES
	Total	♂	♀	
				Metrical differences between straight and curved length and breadth:
Sacrum				
Length				
Midventral straight	95–117	95; 104	108–117	Total 3–15 (♂ 9, 15; ♀ 3) curved > straight
Midventral curved	110–120	110; 113	116; 120	
Breadth				
Straight	100–118	103; 118	100–118	Total 2–5 (♂ 4, 5; ♀ 2) curved > straight
Curved	105; 108	108	105	
Index				
Length-breadth	88.0–108.2	101.0–108.2	88.0–104.4	
Curvature (longit.)	86.4–97.5	86.4; 92.0	97.4; 97.5	
Sternum				
Length				
Manubrium	44–58	46–58	44–47	
Corpus	76–129	100; 129	76–88	
Breadth				
Manubrium (max.)	47–71	61–71	47–58	
Corpus (max.)	30–46	40; 46	30–34	
Thickness				
Manubrium	10–20	14–20	10–15	
Index				
Breadth-thickness (manubrium)	21.1–32.8	21.1–32.8	21.3–25.9	
Length (corpus-manubrium)	26.4–61.8	36.4; 58.0	51.1–61.8	

	Ranges: Right			Ranges: Left			RIGHT AND LEFT			
	Total	♂	♀	Total	♂	♀	+ R (mm.)	R = L (cases) ♂	R = L (cases) ♀	+ L (mm.)
Scapula (♂ 3, ♀ 7 [pairs: ♂ 1, ♀ 3; singles: ♂ r 1, ♀ r 1])								♂	♀	
Morph. breadth	130–167	159; 167	130–146	132–157	157	132–143	2–3	..	1	2
Morph. length	84–107	95; 107	84–95	86–96	96	86–93	2	..	1	1–2
Morph. breadth										
Fossa infraspin.	91–138	122; 138	91–111	92–124	124	92–112	..	..	..	1–2
Fossa suprespin.	46–64	46; 64	50–53	41–51	51	41–50	3–13	..	..	5
Length										
Margo axillaris	101–147	121–147	101–126	105–122	122	105–118	2	..	1	4
Spina scapulae	118–142	135–142	118–128	115–135	135	115; 116	2–5	1	..	.
Fossa articul.	32–45	43–45	32–40	33–41	41	33–37	1–4	..	..	1
Breadth										
Fossa articul.	22–32	29; 32	22–27	21–32	28; 32	21–24	1–2	1	..	
Index										
Scapular (morph.)	59.6–66.9	59.8; 64.1	59.6–66.9	61.0–65.9	61.2	61.0–65.9	..			
Fossa articul.	62.5–74.4	65.9–74.4	62.5–71.1	63.6–78.1	68.3; 78.1	63.6–64.9	..			
Clavicula (♂ 9, ♀ 13 [pairs: ♂ 4, ♀ 6; singles: ♂ r 1, ♀ l 1])										
Length (max.)	124–154	142–154	124–147	124–157	142–157	124–144	1–3	2	1	1–4
Shaft (cross sect.)										
Vertical	8–12	8–12	8–10	8–13	11–13	8–10	1		2	1–2
Sagittal	8–11	8–11	8–10	9–12	10–12	9–10	..	4	3	1–2
Acromion (breadth)	18–34	26–34	18–24	16–36	28–36	16–23	1–3	..	..	1–2
Index										
Cross section (shaft)	72.7–120.0	72.7–120.0	80.0–100.0	80.0–118.0	100.0–118.0	100.0–118.0				
Humerus (♂ 18, ♀ 11 [pairs: ♂ 8, ♀ 4; singles: ♂ r 2, ♀ r 2, l 1])										
Length (max.)	265–324	265–324	270–296	263–328	288–328	263–280	3–11			
Breadth										
Upper epiphysial	44–58	44–58	43–50	42–52	43–52	42–46	1–4	1	..	1–4
Lower epiphysial	47–69	56–69	47–60	45–65	56–65	45–56	1–3			1–2

TABLE 15 (Continued)

	RANGES OF ABSOLUTE MEASUREMENTS AND INDICES						METRICAL DIFFERENCES (INDIVIDUAL) BETWEEN RIGHT AND LEFT			
	Ranges: Right			Ranges: Left			+ R (mm.)	R = L (cases)		+ L (mm.)
	Total	♂	♀	Total	♂	♀		♂	♀	
Shaft diameters										
Maximum middle	16–31	19–31	16–22	16–30	19–30	16–21	1–4	2	1	1
Minimum middle	14–22	15–22	14–20	14–20	16–30	14–16	1–4	2	1	1–8
Caput diameters										
Longitudinal	38–51	41–51	38–45	37–48	39–48	37–42	2–4	1	1	1
Transverse	36–50	39–50	36–42	37–47	38–47	37–40	1–3	..	1	1
Index										
Shaft (cross sect.)	63.6–100.0	67.7–88.0	63.6–100.0	66.7–100.0	66.7–96.7	70.0–100.0				
Caput	91.1–102.1	95.1–102.1	91.1–100.0	95.1–100.0	97.4–97.9	95.1–100.0				
Radius (♂ 13, ♀ 8 [pairs: ♂ 5, ♀ 3; singles: ♂ r 2, l 1; ♀ r 1, l 1])										
Length										
Maximum	195–252	221–252	195–217	193–241	217–241	193–212	2–5			..
Physiological	186–240	211–240	186–206	183–229	205–229	183–203	2–6	.	..	1–2
							Difference (indiv.) betw. max. and physiol. length			
							+ R: R	+ L: L		
							total	total		
							9–15	(2?)9–14		
							♂	♂		
							9–15	(2?)10–14		
							♀	♀		
							9–11	9–12		
Shaft diameter										
Transverse	14–21	15–21	14–16	13–20	15–20	13–17	1–3	1	..	1–2
Sagittal	10–17	11–17	10–11	10–14	10–14	10–11	..	1	3	..
Capitulum diameter										
Transverse	14–25	14–25	20	19–25	21–25	19–20	1–2	1	1	1
Sagittal	13–26	13–26	19–25	19–26	21–26	19–24	1–4	..	2	1
Index										

♀ r 1, 12])										
Length										
Maximum	215–270	241–270	215–239	211–267	241–267	211–259	3–6	1	..	2
Physiological	187–238	212–238	187–211	182–236	212–236	182–204	1–9	1	..	2
							Difference (indiv.) betw. max. and physiol. length			
							+ R: R	+ L: L		
							total	total		
							28–34	26–48		
							♂	♂		
							28–34	26–34		
							♀	♀		
							28–29	27–48		
Olecranon										
Depth	23–34	23–31	23–34	22–31	22–31	22–25	1–2	2	..	1
Shaft diameter										
Dorsovolar	13–24	16–24	13–17	13–23	15–23	13–16	1–2	2	2	1
Transverse	12–17	13–17	12	10–17	11–17	10–12	1–2	3	..	1–3
Circumference	35–50	36–50	35–38	35–48	35–48	35–36	1–2	2	2	1
Index										
Cross section of shaft	58.3–100.0	58.3–100.0	70.6–92.3	60.9–92.3	60.9–92.3	62.5–84.6	..	..	..	.
Caliber (length-thickness)										
With max. length	13.3–18.9	13.3–18.9	15.2–16.7	14.5–18.6	14.5–18.6	15.4–17.1	.	.		.
With physiol. length	15.3–19.7	15.3–19.3	17.3; 19.3	16.4–21.1	16.4–21.1	17.4–19.3	..	.	..	..
Os coxae (♂ 8, ♀ 6 [pairs. ♂ 3, ♀ 2; singles: ♂ r 1, l 1; ♀ r 1, l 1])										
Height	102–225	120–225	181–185	135–223	207–223	135–192	11; 46			2–4
Breadth	137–178	149–158	137–178	137–159	156–159	137–148	41	.	.	2–7
Index (coxal)	65.4–98.3	65.4–77.8	74.1–98.3	70.0–101.5	70.0–74.3	74.9–101.5	..		.	..
Femur (♂ 17, ♀ 14 [pairs: ♂ 8, ♀ 6; singles: ♂ r 1; ♀ r 1, l 1])										
Length (physiol.)	361–441	374–441	361–394	360–446	373–446	360–395	1–7		...	1–8
Epiphysial breadth										
Upper	82–102	88–102	82–83	63–104	95–104	63–89	1	1	.	2–3
Lower	66–88	70–88	66–71	65–88	69–88	65–73	1	1	1	1–2

	RANGES OF ABSOLUTE MEASUREMENTS AND INDICES						METRICAL DIFFERENCES (INDIVIDUAL) BETWEEN RIGHT AND LEFT			
	Ranges: Right			Ranges: Left			+ R (mm.)	R = L (cases)		+ L (mm.)
	Total	♂	♀	Total	♂	♀		♂	♀	
Shaft diameter										
Upp. transverse	27–38	27–38	27–35	28–38	29–38	28–32	1–3	2	1	1–10
Upp. sagittal	19–28	19–28	19–25	20–29	20–29	20–24	1–9	2	1	1
Middle transv.	20–29	25–29	20–25	21–30	27–30	21–25	. .	1	2	1–2
Middle sagittal	22–33	26–33	22–27	22–35	27–35	22–26	2	. .	2	1–2
Caput diameter										
Transverse	38–51	38–51	40–43	38–52	38–52	39–42	1	3	. .	1
Sagittal	39–52	39–52	40–43	39–52	39–52	39–42	1	5	. .	1–2
Index										
Robusticity	12.3–13.7	12.3–13.7	12.3–13.7	12.1–14.7	12.3–14.7	12.1–13.2				
Platymeric	63.3–92.6	66.7–80.0	63.3–92.6	64.5–76.3	66.7–76.3	64.5–75.9				
Pilasteric	88.0–122.2	93.1–122.2	88.0–111.5	88.0–120.7	96.7–120.7	88.0–113.0				
Caput	97.4–100.0	97.4–100.0	97.6–100.0	97.4–100.0	97.4–100.0	97.6–100.0				
Patella (♂ 12, ♀ 11 [pairs: ♂ 6, ♀ 5; singles: ♀ l 1])										
Height	34–50	41–50	34–40	34–50	44–50	34–45	2–5	1	1	1–10
Breadth	39–50	42–50	37–42	38–50	43–50	38–43	2–3	1	2	1–5
Index										
Height breadth	87.8–106.5	92.0–106.5	87.8–92.7	82.9–107.8	91.7–104.7	82.9–107.8	. .			
Height	51.7–67.1	58.2–67.1	51.7–56.7	51.4–64.8	56.1–64.8	51.4–60.9				
Tibia (♂ 16, ♀ 11 [pairs: ♂ 7, ♀ 5; singles: ♂ r 1, l 1; ♀ r 1])										
Length										
Spinomalleolar	297–364	311–364	297–313	284–367	324–367	284–313	1–16		1	3–11
Physiological	293–370	305–370	293–312	285–348	319–348	285–302	3–22	1		2–4
Breadth										
Upper epiphysial	63–82	64–82	63–72	63–81	65–81	63–70	1–4	1	3	1
Shaft diameter (for. nutricium)										
Transverse	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cnemicus	55.0–100.0	55.0–100.0	64.0–75.0	58.8–100.0	58.8–100.0	62.1–75.0	.	..	..	..
Fibula (♂ 8, ♀ 10 [pairs: ♂ 3, ♀ 5; singles: ♂ r 1, l 1; ♀ r 1])										
Length	291–354	326–354	291–308	290–352	320–352	290–306	1–3	..	1	2–5
Shaft diameter										
Maximum	13–19	14–18	13–19	12–21	17–21	12–19	1	.	2	1–4
Minimum	9–15	11–13	9–15	9–17	11–17	9–15	1–2	..	3	1–4
Index										
Shaft (cross sect.)	69.2–92.9	71.5–81.3	69.2–92.9	64.7–82.4	64.7–82.4	66.7–80.0	..	.	..	..
Talus (♂ 9, ♀ 8 [pairs: ♂ 4, ♀ 3; singles: ♂ r 1; ♀ r 1, l 1])										
Length	44–55	49–55	44–46	40–54	49–54	40–50	1–6		..	1–2
Breadth	38–49	40–49	38–47	39–51	40–51	39–45	6	1	..	1–3
Height	29–39	32–39	29–31	29–39	33–39	29–32	1–2	2	..	1
Trochlea										
Length	30–39	32–39	30–34	29–37	30–37	29–33	1–7	..	..	1
Breadth	27–34	27–34	27–29	24–31	24–31	27–29	1–6	1	1	2
Index										
Length-breadth	79.5–97.1	79.5–97.1	87.0; 96.7	80.0–97.1	80.0–97.1	87.9–93.1				..
Length-height	63.6–73.6	63.6–73.6	64.4–70.5	63.8–75.0	64.7–72.2	63.8–93.1	..	.	..	.
Trochlear	79.4–97.1	79.5–97.1	79.4–96.7	80.0–100.0	80.0–97.1	87.9–100.0	..	..	.	..
Calcaneus (♂ 11, ♀ 7 [pairs: ♂ 4, ♀ 2; singles: ♂ r 2, l 1; ♀ r 2, l 1])										
Length	61–85	61–85	64–68	62–83	65–83	62–69	2	1	1	4
Breadth										
Minimum	20–31	20–31	24–26	21–32	24–32	21–30	..	..	1	1–4
Sustentaculum	36–45	36–45	36–39	37–46	37–46	38–40	.	..	2	1–2
Height	31–48	32–48	31–42	30–47	43–47	30–43	1	1	2	.
Index										
Length-breadth	53.0–62.3	55.4–60.0	53.0–62.3	56.1–61.5	61.3	56.1–61.5	.		.	
Length-height	48.4–64.0	49.2–64.0	48.4–63.2	48.4–65.2	56.6–62.7	48.4–65.2	.			

Morphological. Among the twenty-one radii in our collection there are two distinguished by a stronger degree of curvature of the shaft, thereby representing a morphologically inferior mark. They are from Palutat Cave (B2 ♂) and Glacier Island (1 ♂). Although showing varying caliber conditions the radii from Palugwik Village, (Stratum III, Skeleton I ♂) are markedly massive. Another radius from the same site (Stratum IV, Skeleton III ♀) has a strongly developed crista interossea, and Palutat East Point (III ♂, right) an unusually large capitulum.

Metrical. The maximum and physiological lengths of the radius with world ranges between 190–288 mm. and 179–276 mm. respectively lie in our bones between 193–252 mm. and 183–240 mm., both sexes combined. They occupy, as will be noted by comparison, the lower regions of the world ranges. Differences between the two lengths, naturally in favor of the maximum length, amount to 9–15 mm. on the right side, and to (2?) 9–14 mm. on the left. The differences between right and left as also those of sex are all in favor of the male and may be seen listed in table 15.

The cross section index of the shaft depending to a strong degree on the development of crista interossea and commanding a world range between 61.5–90.9 (Martin, '28, p. 1111) lies between our male values of 52.4–94.4 and between the female ones of 62.5–71.4 on the right side, and between 62.5–77.8 and 66.7–77.8 on the left. It exceeds the maximum value with 94.4 in the right bone of P. E. P. III ♂, and falls below the minimum value with 52.4 also in the right radius of P. C., B2 ♂.

The caliber index, involving the physiological length and the minimum circumference attains 17.9 and 19.9 in the right and left radii of P. C., C1 ♂, and 14.8 and 14.6 in P. C., D ♀. These individual figures reveal a difference between the two sides in favor of the left bone in the first and an equality of figures in the second instance. There is furthermore a decisive sex difference to be noted between the two instances quoted showing the male radius to be more robust than the female.

Ulna:

Paired	(r + l)	♂6 = 12;	♀2 = 4
Single	r	♂ = 1;	♀ = 1
	l	♂ = ..;	♀ = 2
	Total	♂13;	♀7. Grand total 20

Morphological. Curvature of the shaft of the ulna, per se an indication of morphological inferiority as already referred to in connection with the radius, is also present in a number of our ulnae. The physio-

logical reason for this peculiarity is to be seen in the greater mechanical demand on the forearm which responds by curving, and the enlargement of cristae interosseae of both forearm bones which automatically brings about a wider spread of the interosseous ligament. Strongly curved ulnae were noticed in P. C., A ♂, and a marked part curvature of the proximal portion in P. V., Strat. III, Skel. I ♂, which latter is further distinguished by general massiveness. An extremely developed crista interossea and corroborating the above statement is that of P. C., C1 ♂. Periostitic affection of the crista, a condition for which statistical data are lacking entirely, was seen in P. C., A ♂. With regard to curvature of the shaft and its etiology as stated above, the condition of straightness appears to be an advanced morphological status which predominates in Europeans. A good example for this is that of P. E. P. I ♂ (?).

Metrical. The measurements of maximum and physiological length of the ulna differ in our series for the right bones by 28–35 mm. in the males and by 28–29 mm. in the females; the differences in the left ulnae range in the males between 26–34 mm., and in the females from 27–48 mm., all differences naturally in favor of the maximum length. The measurements themselves run for the maximum length of the right side from 241–270 mm. in the males and from 215–239 mm. in the females, in the left bones from 241–267 mm. in the males and from 211–259 mm. in the females. The averages of maximum length yield 257.2 mm. in the males and 230.6 mm. in the females while as to right and left, the sexes combined, the averages come to 249.9 mm. and 245.8 mm., showing in both instances the prevalence of the male over the female length and the excess of the right over the left side. The differences between right and left ulnae are, for the maximum length, with a total of from 3–6 mm. in favor of the right side against 2 mm. for the left and an equality of measurement (R = L) in one case. Somewhat similar are the results for the physiological length; discrepancies are due here to the olecranon height extensions which vary in individual cases.

The cross section index of the shaft is more closely dependent on the development of crista interossea than is the case with radius. The individual indices extend from 58.3–100.0 in the male ulnae of the right side, the female indices of the same side ranging from 70.6–92.3. The corresponding figures for the left side are 60.9–92.3 and 62.5–84.6. Martin's individual figures ('28, p. 1116) for a general range of the index run from 67–100. Our values then fit well into that range and in three instances below its minimum index.

The length-thickness or caliber index has been computed from either the physiological or the maximum length and the minimum circumference of the ulna, which in our ulnae extends from 35–50 mm. Starting uniformly, right and left, male and female with 35 mm. as the lowest circumference, except for a male bone with 36 mm., there appears to exist all the same a slight preponderance on the right side in measurement as well as sex, i.e., male. The physiological length appears to be best suited for the caliber determination and shall be briefly discussed here; the index with the maximum length has also been listed in table 15. It will be noted at first glance that on account of the more extensive maximum length, the indices in which it is employed, range below the indices using the physiological length. These indices attain higher figures in the left bones as compared with the right for the reason of greater length extension of the right over the left bone which is typical for the human ulna. The indices range from 15.3–19.7 for the right, and from 16.4–21.1 for the left side. Martin's ('28, p. 1112) world range extends from 11.7–19.7, where the highest values testifying to the greater robusticity of the ulna go to the Europeans, and to the greater slenderness in the primitive races.

Os coxae:

Paired	(r + l)	♂3 = 6; ♀2 = 4
Single	r	♂ = 1; ♀ = 1
	l	♂ = 1; ♀ = 1
		Total ♂8; ♀6. Grand total 14

Morphological. The specimens, in not too good a state of preservation, yielded to only a limited study. The typical sex characters are as a rule well marked which refers also to such traits as a wide ischiadic notch and an obtuse pubic angle in the female pelvis. The obturate foramen here is also of a triangular shape with its basis situated anteriorly, in contrast to the more oval form of the male foramen. In a number of our ossa coxae the tuberculum obturatorium pubicum is markedly developed (P. C., B1 ♀; P. C., C1 ♂; Txw, Large Cave, ♂).

Metrical. The measurements taken were confined to those of the coxal (pelvic) height, the coxal breadth and to the index computed from these two quantities. Judging from the differences (see table 15) the right halves of the pelvis exceed the left ones in both height and breadth which applies also to the sexes. This status, however, cannot be conclusive on account of the paucity and uncertainty of our material.

The coxal index varies in the males from 65.4–77.8 in the right, and from 70.0–74.3 in the left ossa coxae, while the female figures range

from 74.1–98.3 in the right, and from 74.9–101.5 in the left bones. The conspicuous differences in these two series may be interpreted as truly sexual divergencies, signifying the female characteristic of an altogether lesser pelvic height.

Lower extremity

Femur:

Paired	(r + l)	♂8 = 16;	♀6 = 12
Single	r	♂ = 1;	♀ = 1
	l	♂ = ..;	♀ = 1
	Total	♂17;	♀14. Grand total 31

Morphological. In its general appearance the femur is well developed but, as is the rule, less massive in the female. Anterior curvature of the shaft is not very outspoken, sufficiently however to produce pilaster formation of linea aspera, a condition which predominates in various degrees of development, but quite marked, in P.C., B2 ♂; P. V., Strat. III, Skel. I ♂, and others. The simultaneous enlargement of trochanter minor, present in almost all of our specimens, may perhaps stand in causative relation to the pilaster, and be of occupational origin (canoeing, squatting, etc.).

Metrical. The principal length measurement, the so-called physiological length, varies in our femora from 361–441 mm. on the right, and from 360–446 mm. on the left side. On the basis of a world range of this measurement (Martin, '28, p. 1133), running from 340–536 mm., the present values are seen to occupy rather low stations. In addition to the usual sex differences, the bones of the two sides differ in the typical fashion, i.e., the left femur exceeding the right in length. The differences are collectively scheduled in table 15. Average figures accounting for the differences of size and sex are as follows: The male and female averages, right plus left, amount to 413.7 mm. and 379.0 mm. respectively; male against male, right to left, yield averages of 412.3 mm. and 415.3 mm., the females under the same conditions 376.2 mm. and 381.3 mm. They clearly show the smaller size of the female bones as well as the prevalence of the left bone over the right in both males and females.

The most important indices from femoral measurements are as follows:

1. Robusticity index. This index $\frac{\text{Sum of cross section diameters at middle of shaft} \times 100}{\text{Physiological length}}$ varies in our femora between 12.1–14.7 with scarcely any differences in the sexes, although the female averages in various human groups fall slightly below those for the males according to Martin's tabulation ('28, p. 1134).

If here the Negroes in indication of relatively slender femora, possess the lowest average of 11.8, while the Japanese, marking the other extreme, yield 13.1 on an average, it is easily recognized that our indices rather incline toward the latter status, i.e., toward greater massiveness. The Anthropomorphs without exception have indices above 15.0, even 18.4 as in the Gorilla, while the slender Hylobates femur comes to only 10.8 (p. 1134).

2. Platymeric index. The cross section index below the lesser trochanter with a total range of from 63.3–80.0 falls platymeric, i.e., below 84.9, in all instances except in P. V., Strat. III, Skel. II ♀, where is attains 92.6 indicating euromery. The right femur as a rule is more platymeric than the left, which holds for both males and females. Quite interesting are the conditions in the Anthropomorphs where only Orang-utan with an average index of 71.2 is outspokenly platymeric against platymery to a lesser degree in Gorilla with 81.0, Chimpanzee and Hylobates both with 82.8 (Martin, '28, p. 1140).

3. Pilasteric index. The cross section index of the diaphyseal midst, accounting there for the development of linea aspera (pilaster), ranges in our series, from 88.0–122.2. Most of these indices fall above the 100 mark, i.e., show pilaster formation in various degrees which holds also good for the female femora although almost invariably they range below the males, they are less pilasteric. However, there are a number of instances in both sexes which fall short of the 100 mark, such as in the males: P. C., C1 ♂ with 93.1 and 96.7, right and left, and in the females: P. C., D ♀ with 88.0 likewise on both sides.

4. The differences between the vertical and transverse diameters of the femur head are quite insignificant although, in accord with the general status, slightly in favor of the vertical diameter in certain cases. The caput indices of our femora range individually from 97.4–100.0 with most of them at 100.0 or close to it and with an equal distribution in the sexes as well as to right and left. Consulting the figures on table 15 it will be found that those for the cross section measurements vary more than the indices computed from them, but this answers to the general condition in this respect.

Patella:

Paired	(r + l)	♂6 = 12;	♀5 = 10
Single	r	♂ = ..;	♀ = ..
	l	♂ = ..;	♀ = 1
	Total	♂12;	♀11. Grand total 23

Morphological. No morphological distinctions were recorded.

Metrical. The two principal measurements of height and breadth fall comfortably in the ranges which Martin ('28, p. 1155) gives for Europeans and Chubut-Patagonians, namely, 30–50 mm. for the height and 34–51 mm. for the breadth. The individual values for the patellar height in our series of twenty-three come to 50 mm. both right and left, but differ sexually by a decisive division between the male and female ranges. Very similar proportions obtain in the breadth measurements. The measurements for right and left seem somewhat to favor the left side, a feature which perhaps is related to the asymmetry in the sizes of the long bones of the lower extremity where those of the left generally exceed those of the right.

The height-breadth index ranges in Martin's table ('28, p. 1155) from 85.4–147.0, in comparison to which our ranges maintain rather medium stations. Peculiar differences between the two sides occur in P. V., Strat. III, Skel. I ♂ with 93.6 right and 102.2 left, and in P. V., Strat. III, Skel. II ♀ with 89.7 and 107.1 in the same order. These discrepancies look almost like a mistaken assortment of the four patellae in question which, however, I convinced myself is not the case.

The height index $\frac{\text{Height of patella} \times 1000}{\text{Combined lengths of femur and tibia}}$ of the same side affords a fair interpretation of the patellar height extension in proportion to the lengths of the long bones of the lower limb. The higher therefore the index, the greater the height of the patella. Martin ('28, p. 1155) gives an average height index of 52.2 for Hominids. Our figures, individual from 51.4–67.1, would give rise to distinctly higher averages and thus approximate the status of the Mongol (above 55.0) in contrast to the Negroes who as a rule range only up to 49.9.

Tibia:

Paired	(r + l)	♂7 = 14;	♀5 = 10
Single	r	♂ = 1;	♀ = 1
	l	♂ = 1;	♀ = ..
	Total	♂16;	♀11. Grand total 27

Morphological. A conspicuous morphological feature in our tibiae is the outspoken tendency toward a retroversion of the head, i.e., the proximal epiphysis of the bone. One is concerned here with a morphologically inferior trait found not only in Anthropomorphae but also in Homo primigenius, and with a primitive stage in the development of the tibia noticeable in the European fetal condition. The latter however is simply transitional and not an enduring state as observed in primitive human varieties where mechanical causation is to be considered.

This holds also true for the bilateral compression as expressed by the cnemic index (see below).

Metrical. The maximum tibial length in our series ranges in the males from 297–367 mm., in the females from 284–313 mm. thus occupying regions in the lower extensions of Martin's ('28, p. 1157) world range of 283–445 mm. for the males and of 280–390 mm. for the females. It will be observed that the female bone is somewhat shorter than that of the male. The total averages for the maximum (spinomalleolar) length of the tibia in our series are for the males 343.6 mm., for the females 305.3 mm., the difference coming to 38.3 mm. in favor of the males. The length proportion between right and left however is not so outspokenly in favor of the left bone as observed in the femur. Supplementing the figures of individual differences in table 15, the averages between right and left amounting to 342.4 mm. and 344.8 mm. in the males, and to 309.9 mm. and 300.8 mm. in the females show a slight excess of the left length in the males, the females being uncertain because of their paucity. This is not quite in harmony with Martin's data on the right–left proportion of the tibia in general ('28, p. 1157):

	♂	♀
R > L	43%	32%
L > R	25%	54%
R = L	29%	14%

The index cnemicus with a world range of 50–90 and involving the transverse and sagittal diameters of the shaft at the foramen nutricium, covers in our tibiae the values from 55.0–74.2 (100.0) in the males and from 62.1–75.0 in the females. Most of the individual indices come under the heading of platycnemy (x–62.9), some of mesocnemy (63.0–69.9) and only a few of eurycnemy (70.0–x). The index of 100.0, i.e., equality of the two measurements involved belongs to P. C., C2 ♂. The index proportion between right and left in the same skeleton is variable.

Fibula:

Paired	(r + l)	♂3 = 6; ♀5 = 10
Single	r	♂ = 1; ♀ = 1
	l	♂ = 1; ♀ =
	Total	♂8; ♀11. Grand total 19

Morphological. There are no outstanding features from the descriptive point of view, except an unusual degree of massiveness without being pathological, in a fibula fragment from P. V., Strat. III, Skel. II ♀. Channelling of the shaft is, as a rule, well developed while anterior concavity is only weakly represented.

Metrical. The length measurements in our fibulae have a total range from 290–354 mm. and although judging from the ranges for right and left, the former slightly exceeds the latter, the length of the left fibula in individual cases exceeds that of the right bone (see table 15), and more so in the female as compared to the male which would be in accord with Martin's data of proportion in the discussion of tibia. The length as such is conspicuously greater in the male bone, with the differences, however, in favor of the right side in both male and female.

The cross section index of the shaft middle is of only moderate comparative value on account of the variable development of the different crests. It varies in our series from 64.7–92.9, and there is no direct proportional difference between the sexes. Due to the differentiation in shape Martin ('28, p. 1166) cites an index as low as 53.8 in a female Senoi where the fibula resembles a "moderately broad and flat ruler". This is in contrast to our maximum of 92.9 in P. C., D ♀, i.e., a fair approximation of the size of the two measurements involved.

Talus:

Paired	(r + l)	♂4 = 8;	♀3 = 6
Single	r	♂ = 1;	♀ = 1
	l	♂ = .;	♀ = 1
		Total ♂9;	♀8. Grand total 17

Morphological. No distinctive characteristics were observed.

Metrical. From the study of the metrical ranges in table 15 it will be observed that in the absolute measurements the females fall below the males. Slight differences between right and left are quite inconsistent in the few paired bones, i.e., they occur either in favor of the males or the females.

The following indices of the talus have been considered:

1. The length-breadth index: Its total range lies between the values 9.5–97.1 with no distinct differences between sexes or sides. The individual condition bespeaks a rather broad talus bone.

2. The length-height index with a total range from 63.6–75.0 indicates a medium-high talus with occasional higher ones but with no distinct sex or right-left differences.

3. The trochlear length-breadth index ranges from 79.4–100.0 in our series and thereby signifies a somewhat square-shaped trochlea with no distinct differences as to sex or side.

Calcaneus:

Paired	(r + l)	♂4 = 8;	♀2 = 4
Single	r	♂ = 2;	♀ = 2
	l	♂ = 1;	♀ = 1
		Total ♂11;	♀7. Grand total 18

Morphological. Except for the occasionally greater massiveness of the tuber calcanei and its two processes, of processus trochlearis and of sutentaculum tali, there is nothing in this bone that requires special discussion.

Metrical. The length, breadth and height measurements differ sexually in favor of the male, while at the same time, at least for the length and breadth and judging from the listed differences, the left measurements appear to exceed the right ones. Whether that is in bearing with the greater lengths of the left femora and tibiae is to be studied upon a larger material. The length-breadth index (minimum breadth and physiological length) attains, right and left combined, a range of from 55.4–61.3 in the males and from 53.0–62.3 in the females which probably reflects the differences in size referred to above not alone with regard to sex but to sides. The length-height index covers a total range from 48.4–65.2 with no apparent preference to sex or side. Roughly averaging this to 56.8, this figure exceeds any of those mentioned by Martin ('28, p. 1172) which are listed there with 47.0 for Senoi —51.7, for Alemani.

SKELETAL PROPORTIONS — INDICES

The indices of skeletal proportions involving the length measurements of the long limb bones and including that of the clavicula are strongly dependent upon individual variation, although the major races (Europaeid, Mongolid, Negrid) represent fairly clearly the physical differences obtaining in their body proportions. The problem becomes still more complicated under consideration of the length variations shown by the two sides and in the sexes. The indices of skeletal proportions — six in number — are briefly discussed in the following paragraphs and their ranges listed in table 16.

1. Humeroclavicular index. This index first introduced by Broca (1862) claims a sex difference in favor of the female in Europeans and Negroes. This could not be corroborated in our material, always under the consideration however of the smallness of our series, and although the highest female individual figures of the right and left ranges very slightly exceed the highest male value, the right male and female index values running from 46.7–49.5, and from 45.9–51.3. This slight divergence may also reflect, cautiously considered, the more or less typical length excess of the left clavicula over the right.

2. Humeroradial index. The percental proportion between upper arm and forearm in our series covers indices of brachykerky (x–74.9) up to the upper limit of mesatikerky (75.0–79.9). The total range in

our series of twenty cases extends from 70.9–79.1, twelve of which are brachykerkic (5 ♂, 7 ♀), and eight mesatikerkic (7 ♂, 1 ♀). Our ranges seem to reveal a tendency toward higher female indices which would comply with the usual status of a shorter female radius. Less pronounced are possible differences between right and left, since the relative foreshortening of the bones of the left upper limb equalizes the proportions among themselves.

Martin ('28, p. 395) lists indicate that the Europeans have the shortest, the Negroids the longest forearms while the Mongoloids hold a medium position. Among the Anthropomorphs, Hylobates and

TABLE 16

Indices of skeletal proportions.

INDICES	RANGES: RIGHT			RANGES: LEFT		
	Total	♂	♀	Total	♂	♀
Humeroclavicular	45.4–50.4	46.7–49.5 (5)[1]	45.4–50.4 (5)	45.9–51.3	47.8–50.3 (5)	45.9–51.3 (4)
Humeroradial	70.9–79.1	70.9–79.1 (7)	72.2–73.3 (4)	71.8–77.5	71.8–77.5 (5)	73.4–75.7 (4)
Femorohumeral	71.6–79.0	71.9–79.0 (8)	71.6–75.2 (5)	70.9–75.5	71.7–75.5 (6)	70.9–73.1 (4)
Femorotibial	79.2–82.7	80.8–82.7 (5)	79.2–82.3 (3)	75.4–84.4	80.5–84.4 (6)	75.4–80.9 (4)
Tibioradial	65.6–72.4	65.6–72.4 (5)	65.7–69.6 (4)	65.0–68.9	65.0–68.9 (4)	65.5–68.4 (3)
Intermembral	69.9–84.1	69.9–84.1 (5)	71.0–71.4 (3)	68.7–71.0	68.7–71.0 (3)	69.0–70.8 (3)

[1] Figures in parentheses signify numbers of cases.

Orang-utan possess the relatively longest forearms (indices from 106–116, and from 94–104), while intermediary between them and man in general is found Chimpanzee (91–96). Gorilla approximates the human state (indices ranging from 78–85).

3. Femorohumeral index. Somewhat more distinctive are the differences which obtain in this index between the sides as well as the sexes, due to the more or less outspoken length dimensions, i.e., a longer right humerus and a comparatively longer left femur. The right total range of 71.9–79.0 stands against a female one of 71.6–75.2, and a left male range of 71.7–75.5 against a female range of 70.9–73.1.

4. Femorotibial index. The percental proportions between the lengths of the two bones involved in this index is governed more by their individual relation than by the typical length differences favoring the left bones. Slight differences which nevertheless occur in our ranges should be adjudged all the same from this angle. Most of our indices are grouped around a central index of 80.0, and with this they rather conform to the European status instead of the American as shown in Martin's lists ('28, p. 418).

5. Tibioradial index. Similarly different as in the femorohumeral index are the length dimensions of tibia and radius, i.e., a relatively longer left tibia is countered by a relatively longer right radius and vice versa. Always considering the small number of our series, that discrepancy seems to be indicated in the percental proportions. The slightly higher right male range of 65.6–72.4 stands in opposition to the somewhat lower left male range of 65.0–68.9. The same relative proportion obtains in the females, where a right range of 65.7–69.6 is countered by a left one of 65.5–68.4.

The averages of this index oscillate, according to Martin's table ('28, p. 429) between 63.5 in Parisians and 70.9 for Fuegians, so that our tentative averages of 68.0 ♂ and 67.0 ♀ would rather fall into the higher stations of the tibioradial index.

6. Intermembral index. Formula: $\frac{\text{Maximum length of humerus + radius} \times 100}{\text{Physiol. length of femur + Condylomall. length of tibia}}$. If in accordance with general findings the length of the left lower exceeds that of the right lower extremity and vice versa the length of the right upper exceeds that of the left upper extremity, the indices according to the above formula should conform to such proportions. This is the case even in our small series of cases where the right males range from 69.9–84.1 in contrast to the left ones from 68.7–71.0, while the right and left female ranges, similarly, run from 71.0–71.4 and from 69.0–70.8. It will furthermore be seen that the females, right as well as left, range below the males due to their typical foreshortening of the upper extremity, and in our series there is even an indication of the left female range falling below the right.

Martin ('28, p. 428), citing Stratz, gives an intermembral index of 80.0 to the Europeans, of 88.0 to the Japanese, and of 92.0 to the Eskimo, which in the latter two varieties is due rather to a shorter lower than a longer upper extremity. Judging from these averages, our series appears to be more closely related to the European than to the other two varieties.

LONG BONES AND STATURE

Calculations by means of coëfficients between the long bones of the two pairs of limbs (without the hands and feet) and stature were carried on according to Manouvrier's scheme (Martin, '28, pp. 1069–70). The available bones numbered 137 of which 82 were male and 55 female which, affording ranges, segregated from the combined calculations of the various bones involved, of 140.2–171.6 cm. ♂ and of 140.0–169.2 cm. ♀, gave rise to a male and female stature average of 159.1 cm. and 149.1 cm. According to the standards (Martin, '28, p. 246) and centering about a total human stature average of 165 cm., our male average of 159.1 cm. falls into the small class in close proximity however to medium stature while the female average of 149.1 cm. marks the medium stature by its fraction. They fit in with the data on small American statures among whom are various Eskimo groups as assembled by Martin ('28, p. 252). It will be noticed furthermore that the difference between the sexes of almost any human variety corresponds to the usual figure of or around 10 cm.

SKELETOCRANIAL CORRELATIONS

The preservation of the long bones of the skeletons belonging to the three type crania (see section on cranial typology) incited an attempt to correlate skeletological and craniological findings, although it became clear at the very outset that metrical correlations between the two complexes mentioned might reveal themselves only upon a more numerous material than the present rather limited series. Morphological correlations on the other hand appear to be more easily realized even in our limited collection. The long bones of P. C., B2 ♂ and C2 ♂, comparatively and with reference to their crania appear to be more graceful in the first case in contrast to the long bones of C1 ♂ which are more massive and robust. At the same time, the radius and ulna as well as the clavicles of C1 ♂ are more curved in accordance with the cruder habitus of the skull to which they belong and as shown in plate 7.

DISCUSSION

The skeletal remains from Prince William Sound, Alaska, which afforded the basic material for the present study, has been subjected to an exhaustive morphologic and metric treatment in order to arrive at a deductive appraisal of their morphological and racial standing or affinity. This exhaustive appraisal however was severely encumbered because of the rather limited number of cranial and osteal specimens.

On the basis of morphologic and metric scrutiny it was possible to differentiate three type crania, the characteristics of which have been laid down in the section on "cranial typology". As type crania there had been recognized three skulls from Palutat Cave: $B2$, $C1$ and $C2$, all males, although the sex determination of $C2$ as male appears somewhat doubtful. The remainder of the crania follow more or less the pattern of those types, except perhaps that craniologically there is no definite replica of $B2$.

The discussion must needs concern itself with (1) the general morphological and metrical habitus of all the crania of our series; (2) the three type crania; (3) the osteology in its various concerns, and (4) the racial composition of the skeletal remains from Prince William Sound, Al.

1. The crania in general. Morphological and metrical. As to general appearance, the skulls of the present series are well-shaped and not distorted by artificial deformation. The detail formations are, as is the rule in human craniomorphology, more plastically worked out in the male, even to the extent that some of the male skulls, e.g., P. C., $C1$ (see plates 1–5) and those from P. E. P., are conspicuously more massive, one might say "manlier", in their general habitus. In spite of this, the relief formations (muscle marks, morphological detail), here as well as in the remaining specimens of our series, are by no means outspokenly crude or overemphasized.

Volume and size of the skulls show quite decidedly the patent differences of sex as they obtain in the American natives. The cranial capacity is aristencephalic with 1554.2 cc. in the males, and euencephalic with 1200.0 cc. in the females, with the further difference however that the male values cover the subdomains of euencephaly and aristencephaly, while the female values are distributed over the oligencephalic and euencephalic divisions. This condition is still better demonstrated by the cranial module which attains a male average of 154.6 (149.3–158.0) mm. against the female 142.4 (137.0–147.3) mm. These figures compare quite favorably with Hrdlička's ('24, pp. 11–15) for Alaska Eskimo, especially in the males whose average attains 153.2 (147.7–160.0) mm., but less so in the females at 148.1 (141.7–152.3) mm. In fact, our own figures in this case lie noticeably below Hrdlička's, both as to average and range, which however may have its cogency in the fewness of cases, i.e., three females against eighteen.

The mutual proportions between the neural and splanchnic divisions of the cranium as expressed by the transverse craniofacial index yields high average figures as a result of the decided bizygomatic extension. The index attains a male average of 99.4 (96.4–105.4) and a slightly

lower female one of 95.6 (92.6–100.8), values which are racially expressive of the broad faces of the crania under investigation and thus fall into the highest portion of Martin's ('28, p. 910) listings of this index. Similarly expressive of neurosplanchnocranial proportions is the transverse jugofrontal index which yields male and female averages of 69.5 (64.3–74.5) and 71.6 (65.2–74.6) where, as in the former index, particularly the differences in bizygomatic breadth are responsible for those of sex.

In the length-breadth, length-height and breadth-height proportions the sexes are uniformly mesocranial (77.0; 79.4), orthocranial (73.4; 74.5) and metriocranial (95.4; 94.1), with the typical female excess of the females over the males in the first two indices, while the breadth-height index exhibits the no less typical, although distinctly weaker preponderance of the male over the female skull due to the smaller female height over that of the male. The combination of the cranial length and breadth diameters in the relation to the cranial height as introduced by Hrdlička in his mean height index of the skull, yields male and female averages of 82.2 and 83.2 which fall below that author's figures for Alaska Eskimo ('24, p. 15) attaining there 85.5 and 84.4 and derived from a large series which doubtless is responsible for the discrepancy. The difference of cranial height in the sexes also brings about the difference in the length-auricular height index in favor of the males, namely, the latter's hypsicranial average of 95.4 (87.6–102.9) against the female orthocranial 94.1 (91.8–96.3).

Postbregmatic elevation over a parallel to the ear–eye plane through the bregma and recognized as a mark of inferior morphology, occurs at a range of from 0.5–6 mm. and at equal male and female averages of 3.2 mm. each. Correlated to this condition is the conspicuous postorbital constriction as expressed by the minimum frontal breadth whose moderate development is an outspoken characteristic of the American native population.

The facial proportions characterized by the upper facial index connote mesoleptenic conditions, i.e., the male average at 55.8 (51.9–57.0) is slightly leptenic while the female average at 54.0 (50.0–58.7) is mesenic but closely approximating lepteny. This is not fully in accord with Hrdlička's figures for Alaska Eskimo ('24, p. 15), where both sexes with 53.7 are mesenic although close to the leptenic domain of the index. But this disparity too may be due to our fewer number of specimens.

The orbital (maxillofrontale width) and nasal indices show the typical sex differences obtaining in most human groups, i.e., the females have higher eyes and broader noses than the males; they are meso-

conchic at 83.6 and hypsiconchic at 85.5, and leptorrhinic at 43.0 and leptomesorrhinic at 46.9. The writer following his practice, has also for comparative reasons, accounted for the orbital index with the lacrimale width.

Prognathy in its three expressions, namely, facial, midfacial and alveolar, differs in the sexes in the more or less typical fashion, i.e., the females of our series are prognathous throughout (77.0°; 79.3°, and 72.7°) against the mesognathous behavior of the males (83.8°; 84.8°, and 80.5°).

Other angular relations of importance are those of the foramen magnum and of the ramus mandibulae. The foramen magnum plane in relation to the ear–eye plane shows an advanced morphological status of male and female averages of — 4° (— 2° to — 10°) and — 6° (— 3° to — 12°) and it will be noticed that the entire series in its ranges reflects this advanced condition.

Of characteristic importance, especially from the viewpoint of sex, is the declination of the ramus mandibulae upon the alveolar plane, pointed out a number of times by the author in his writings ('25, p. 142; '30, p. 123). In the present series the male average attains 74.8° (65° to 84°), the female 69.4° (67° to 73°).

Table 17 contains, for readier comparison, the metrical and morphological findings upon the crania as discussed in the preceding section.

2. *The three type crania.* The three crania from Palutat Cave (*B*2 ♂, *C*1 ♂, *C*2 ♂ ?) have already been referred to. Under the present heading some of the most outstanding distinctions may be reassembled and discussed. A number of these can be pointed out in the perigrams (fig. 11). The cranial vaults rise to different heights above their common line of orientation, the nasion parallel (*e–e′*) to the ear–eye plane line (*E–E′*). This condition is even sustained by the basion-bregma height measurements despite the individual orientation on their ear–eye plane lines. The cranial heights, interestingly enough, are correlated to the occipital extensions of the three crania under discussion in such a fashion that the lowest vault shows the greatest, the highest the shortest cranial length which proportions in corresponding figures are as: *B*2, 127 : 192 mm.; *C*1, 133 : 190 mm., and *C*2, 141 : 185 mm. *B*2 ♂, the lowest and longest of the skulls, is furthermore possessed of a strongly protruding superior occipital squama which gives rise to an inial flexure, less noticeable or absent in the other two type crania *C*1 and 2. Both those formations signify primitive morphological conditions in *B*2, and they are added to by the glabellar development and the depressed nasal onset (root). The latter, together with the anteriorly protruding alve-

olar process of the maxilla and the projected chin, jut the face of *B*2 forward quite conspicuously, more decisively so in fact than in *C*1 and 2 which will be recognized without difficulty in the comparative presentation of normae laterales (plate 2).

TABLE 17

Condensed craniological findings: whole series.

	CRANIA FROM PRINCE WILLIAM SOUND, ALASKA	
	Male	Female
Volume		
Capacity	Aristencephalic	Euencephalic
Size		
Module	154.6	142.4
Neurosplanchnocranial proportions (Index)		
Transv. craniofacial	99.4	95.6
Transv. jugofrontal	69.5	71.6
Index		
Cranial		
L–Br	Mesocranial	Mesocranial
L–H	Orthocranial	Orthocranial
L–auric. H	Hypsicranial	Orthocranial
L–Br	Metriocranial	Metriocranial
Mean height (Hrdlička)	82.2	83.2
Facial		
Upper facial	Leptenic	Mesenic
Orbital (mf)	Mesoconchic	Hypsiconchic
Nasal	Leptorrhinic	Leptorrhinic
Angles		
Foramen magnum	— 4.0	— 6.0
Ramus (alv. Pl.)	74.8	69.4
Prognathy		
Facial	Mesognathous	Prognathous
Midfacial	Mesognathous	Prognathous
Alveolar	Mesognathous	Prognathous

The chin in the latter two crania, positive as in all our specimens, falls, in ear–eye orientation of the skull, definitely behind the incision vertical of the mandible which, although bringing forward the alveolar parts, gives to the faces a rather clumsy expression. This is still better observed in normae frontales (plate 1) where *C*1 particularly presents a crude and massive facial structure, further emphasized in this skull by the extreme bizygomatic extension of 156 mm. as against 140 mm.

in $B2$ and 132 mm. in $C2$. The faces are overtowered by the height of the frontal region which projectively (n–b on e–e') is greatest in $C2$ where it attains 91 mm. against 81 mm. in $B2$ and 86 mm. in $C1$. The morphologic analysis of faces is also influenced by the height of the alveolar processes of the maxillary bone and, dependent thereupon, the incurvation of cristae infrazygomaticae which are easily distinguished in normae frontales of plate 1 and the figure 7, *a* and *d*, illustrating these conditions. It will be noted that the low alveolar process of $C1$ is countered by high and slanting processes in $B2$ and $C2$ which gives to $C1$ the impression of a superoinferiorly compressed face. The orbital and nasal apertures have already been referred to as mesoconchic in $C1$ and hypsiconchic in $B2$ and $C2$. Attention may be called again to the racial peculiarity of the inferolateral angles of the orbits whose roundness seems to have been first described by Adachi ('04). The nasal aperture, as has been stated before is leptorrhinic in $B2$ and $C1$, but mesorrhinic, almost chamaerrhinic in $C2$. In the latter case the impression of conspicuous nasal width which, with 26 mm. is greatest in our three specimens as against 21 mm. in $B2$ and 24 mm. in $C1$, is further emphasized by the breadth of the nasal bones with only slight bilateral constriction.

The morphological detail formations of the face invite a study in configuration, the more so since association of these parts with sensory functions (sight, smell, taste), emotional expressiveness (mimetic musculature) and movement (jaws) is quite suggestive. Aesthetic terms in the description of the skeletal face like crude, refined, savage, harmonious, etc., are indeed not too far-fetched to afford definite impressions.

In the strict morphological sense the various factors of the physiognomic complex of the face center around the shape and size of the large apertures (orbit, apertura piriformis), the lateral fling of the zygomatic processes of the frontal bone, of the frontal expanse, the zygomatic region, the mandible, etc. Most of these admit of descriptive interpretation, even such as the roundness of the inferolateral angles of the orbit; or the observation that the basal outline of apertura piriformis is generally on a level with the deepest incurvation of cristae infrazygomaticae; or the morphological relation of pars nasalis of the frontal bone to the shaping and approximation of the orbits or the nasal aperture, and so forth.[16] Without going into further description of detail it goes without saying that another procedure, the metricoanalytical, is

[16] This is not the place to go into great detail on this highly interesting subject of comparative configurative morphology since it is quite complex and space consuming.

the more precise and indispensable method in this problem. Reducing the entire complex to the two principal diameters of height and breadth, not only the total extensions but the proportional relations of part formations lend themselves to metrical interpretation.[17] For the present, the normae in juxtaposition of the three crania in question (plate 1) may be consulted with regard to the suggestions set forth in the preceding paragraphs.

Norma basilaris offers a number of distinctive characteristics (plate 5). The compact appearance of *C*1 is in direct contrast to *B*2 and *C*2 which is also metrically expressed by the cranial L–Br index amounting to 74.0 and 74.1 in the two latter skulls, but to 77.9 in *C*1. It is furthermore signified by the postopisthial (projective) extension of the crania which is smallest in *C*1. The maxillopalatal complex appears condensed in *B*2 and *C*1, but rather elongate in *C*2 where moreover it is emphasized by the completeness of dentition. Here too the adjoining fossae temporales appear slightly longer and narrower than in *B*2 and *C*1 where they are quite spacious, and in the lumina of which latter the well-developed marginal processes of processus frontosphenoidei of the zygomatic bones show in perspective. The phaenozygous condition of the three crania under investigation is well observed in this norma too. In addition to the massiveness and even crudeness of *C*1 the metrical extension of the zygomatic region is significantly indicated by its bizygomatic diameter of 156 mm. against 140 mm. and 132 mm. in *B*2 and *C*2.

A slight anomaly is noticed in norma basilaris in that fissura sphenooccipitalis is not fully ossified although the specimen is in adult age.

The outstanding feature in norma occipitalis of our type crania is the "house shape" of its contour caused by the sagittal elevation of its roof obtaining in all our crania except in P. V. 1 ♂. The "gable roof" is fully conspicuous in *B*2 in this norma (plate 5), although less outspoken in norma frontalis (plate 1). It depends in this particular case quite definitely on the postbregmatic elevation as pointed out above. The similarity of contour of *B*2 and *C*1 is markedly in contrast to *C*2 of the latter's greater height and narrowness.

3. The osteology. There are only a few morphological distinctions to be reported on the osteal material collected with the crania at the

[17] It is about time that physical anthropologists abandon the term "long face" for "high face" or "narrow and high face". That popular term "long face" should have no place in physiognometrical investigation, skull or head, since length is diametrically opposed to height, and length, metrically determinable (pr-ba), would correctly signify a "long face" but not a "high face".

various sites of Prince William Sound. These for the greater part concern the two principal long bones of the lower extremity. In the femur there is, first, a preponderance of pilasterism as signified by cross section indices of the shaft at 100.0 and above, and which in individual cases attain 120.7 (♂) and 122.2 (♀), dropping in others however to 88.0. Males and females participate at equal numbers in pilasterism. Platymery of the femur, on the other hand, with all the indices below 84.9, signifies an outspoken morphological trait, the females participating throughout although comparatively they are slightly less platymeric. Another feature of morphologic significance, not universally present in our series, however, is platycnemy of the tibia. In our series it occurs at 40.9% against 31.8% of mesocnemy and 27.3% of eurycnemy. The general tendency toward retroversion of the head is another morphologic peculiarity resulting quite probably from the same mechanical demand upon the tibia as platycnemia, namely, muscular tension in certain positions of the body. As these morphologic conditions are metrically expressible, the main interest in osteology lies with the metrical conditions. There are in this respect two factors of outspoken importance, namely, the differences of sex and those between right and left of bodily occurrence.

Regarding sex differences it is to be summarily stated that the female bones range below those of the males in size and in the development of their relief formations. Without going into greater detail it has also been stated that morphological correlations seem to exist between the skull and the long bones of the same skeleton, correlations which metrically can be proven only on more numerous material.

Right-left differences in absolute measurements may best be judged by consulting the figures of the last main column of table 15 (metrical differences between right and left). Some of the differences there are distinctly either in favor of the right or the left side, while the subcolumns at the middle of the same main column contain the number of cases of metrical equality. Judged by the metrical differences then, the lengths of the long bones of the upper extremity (humerus, radius, ulna) appear to be longer on the right side in contrast to the long bones of the lower extremity, at least of the femur. The more exact way of accounting for these variations would be the percental expression of their participation, but as has been mentioned a number of times, a representative statement of that kind could not be attained on account of the paucity of material.

More interpretatively reliable are the indices of skeletal proportions. In their account above and in table 16 it has been demonstrated that

the various indices reflect not only the more or less typical differences among the participating factors as such, but also in their relation to right-left and sex.

Finally the long bones have been utilized in stature calculation according to Manouvrier's method. Although the averages fall rather low in the sexes (159.1 cm. ♂, 149.1 cm. ♀), the individual values beginning in their ranges quite low at 140 cm. in both sexes, reach up markedly high to 171.6 cm. in the males and to 169.2 cm. in the females. However, our averages range below those of Hrdlička's ('42, p. 420) who for Western Eskimo gives average heights of 161.5–166.5 cm. in the males and of 151.0–154.6 cm. in the females.

4. Racial composition. The final but at the same time the most difficult problem concerning the skeletal remains which in this work have been submitted to a methodical study, is the determination of their racial standing or affinity. It has been shown that although there are basic features common to all the crania, there are morphological and metrical differences which speak against a homogeneous racial integration. It seemed to be most promising to carry on an approach toward a racial analysis by accounting for such racial elements as might have entered or influenced a presumably unified racial entity. From the start one is apparently dealing with a basic stratum to be recognized as the aboriginal Western Eskimo which, like any other human variety, might have differentiated into a number of local type variations. In their entirety they are known as the Chugach. "In the historic and recent prehistoric period they were in contact with the Tanaina Athabaskans of Cook Inlet . . ., with the Eyak and Atna Indians of the Cooper River, and with the Tlingit (Yakutat group). . . . The modern Chugach are largely mixed with white. Most of the older mixture was with the Russians . . . and these may have been pure white Russians, or Russians who were mixed with Siberian and Aleut".[18] Lacking any direct type representation of those groups, it is impossible to make any definite statements regarding the racial preponderance, the more so since in our material the findings both morphologically and metrically overlap. Giving the preference to morphology one would have to fall back on our three type crania and recognize P. C., C1 ♂, the crudest and most robust one as the morphologically most inferior and belonging to an old, perhaps primary pre-columbian ethnic stratum. As mentioned above there are several crania in our series approximating the morphological habitus of *C*1 and may therefore be counted in with

[18] This information came to me from Dr. Frederica de Laguna in a letter dated July 11, 1942.

the same category. P. C., *B*2 ♂, the only other exponent of a distinctive morphological appearance in our series appears to be of an extraneous derivation. Its most remarkable feature, the low cranial vault is met with in certain Mongolian groups of Asia (Hrdlička, '24, p. 51) and was recently referred to again by Neumann ('42) as occurring in Aleutians. The third possibility, that of white influence, is connected with a number of hereditary phenomena in genealogical history which concern certain dominant features in mixture and offspring. They reveal themselves in cranial morphology, e.g., in a narrowing of the face, broadening of the forehead, moderation of prognathism, and other morphological conditions. Although our type cranium P. C., *C*2 ♂ ? may show slight mitigations in these respects, it would be rather uncautious to assume positive white influence.

SUMMATION

1. The skeletal material under investigation comprised 18 crania or cranial parts and 250 skeletal bones, some belonging with the crania, but the greater number of them not.

2. The morphological habitus of the bones, crania and skeletal parts, with a few exceptions of a cruder type, represents a medium-to-submedium expressiveness of general relief and special type formations.

3. The crania, on the average, preserving certain typical sex differences, are: meso-, ortho- and metriocranial; leptenic-mesenic, meso-hypsiconchic (maxillofrontale), leptorrhinic and mesoprognathous (ear–eye plane).

4. As to calculated stature our specimens appear to have been submedium.

5. Just as a number of cranial features, fairly predominant in the series studied, suggest Mongolid affinity, this condition is quite outspoken for a number of traits also in certain long bones (femur, tibia).

6. The closest racial affinity (table 13) is demonstrated to exist with Alaska Eskimos, Siberians from Indian Point and, somewhat removed, with the Indians from San Miguel Island, Cal.

7. The Mongolid affinity being thus established for our skeletal material from Prince William Sound, Alaska, attention is to be called again to a low-vaulted skull of Aleutian affinity (?).

8. Eskimo-White amalgamation could not definitely be proven.

9. If, on the other hand, morphological proof were sufficient for ethnic stratification, a semblance of this condition might be stated to exist in the small geographic area under investigation.

10. The fundamental conditions of morphological communanity in the present series is nevertheless demonstrative of a definite type disparity.

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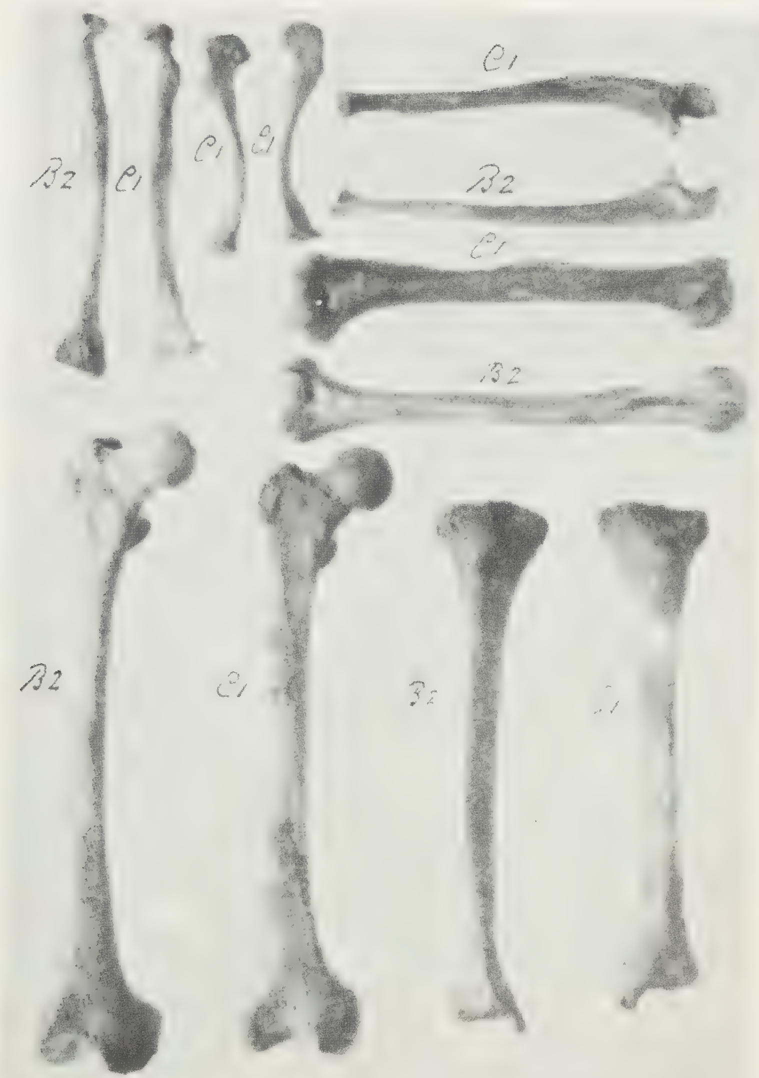

The long bones belonging with the type crania *B*2♂ mat and *C*1♂ mat from Palutat Cave, Prince William Sound, Alaska, in plates 2–6.

REVIEW

MAINSPRINGS OF CIVILIZATION. By ELLSWORTH HUNTINGTON, John Wiley and Sons, N. Y., xii + 660 pp., 1945. ($4.75)

When a man writes a book which is not only, to use his own prefatory words, "an attempt to analyze the role of biological inheritance and physical environment in influencing the course of history," but also an effort "to include an interpretation of the main trends of history in the light of these two factors *as well as* of the cultural factor which is generally the main topic in histories of civilization" — when anybody writes a book attempting all that, it is a pretty safe bet that his stuff is either very good or very bad. Huntington's stuff is never very bad.

This is the culminating volume in a long series of Huntington essays which began with geography, soon extended to climate and exploration, then embraced race, biology, progress, history, and later came to focus on the ancient question of heredity versus environment. Some of us who are old readers of Huntington have for years anticipated this volume with a certain degree of expectancy. It seemed inevitable that this dynamic and brilliant man would attempt a comprehensive book of enormous scope.

The book tries to maintain a balance. Huntington knows well that hereditary biology, physical environment, and social culture all determine the human being. He knows that in the end all the camps of extreme emphasis on one of these factors are intolerantly wrong, and his book as a whole is a prodigious effort to deal comprehensively with all three major variables. Perhaps such an undertaking is impossible at the present day. Almost certainly the man who tries it will be caught in a withering cross-fire between the various camps. Among fanatical "culturalists" in particular Huntington may be praised faintly for his integrative effort.

There are three main sections in the book. First a brief introductory treatise on the general background of civilization, second a 200-page survey on heredity and the interplay of culture with heredity, finally a rambling section of some 19 chapters — nearly 400 pages — delineating the author's lifelong interests in such factors of physical environment as geography, temperature, climate, the seasons, weather and storms, and lastly, the general factor of cycles. It is this last topic which appears to have intrigued Professor Huntington during his most recent years, and here he reaches once again the fresh enthusiasm and speculative journalistic vigor which has so often appeared in his 20 or more earlier volumes.

The section on heredity is sociological and eclectic, not methodological. It contains a good chapter on the American Puritans and a really excellent summary of the origins and character of the Prussian military aristocracy. The author is well aware of the trend of anthropological opinion on race. He skillfully avoids the shallow pitfalls of racism while maintaining vigorously his position that a strong biological factor is present in the determination of national and group character. One of the main features of the book lies in the develop-

ment of a concept of "kiths," which are defined as groups of people possessing a more or less similar culture and language together with the custom of intermarriage. There are microkiths and macrokiths, transitory ones and historically important ones. One of the more important kiths is the English-speaking macrokith, and here is an ingenious way of approaching — journalistically at least — one of the knottiest problems of social philosophy.

The book is meticulously documented throughout, and a good bibliography is included. It touches somehow on almost every topic which so comprehensive a title might be expected to include, and many more. It is excellent reading. For those who possess vigorous and general curiosity it is a treasure house.

W. H. Sheldon,
University of Chicago

REVIEW

CONSTITUTION AND DISEASE. By JULIUS BAUER, Grune and Stratton, N. Y., 2nd edition, xiii + 247 pp., 1945. ($3.50)

The field of constitution and disease, or applied constitutional pathology, is one in which the author is a recognized authority among medical men. This little book should be particularly useful for practicing physicians in giving them a more balanced conception of the relation of the individual constitution to many diseases. Medical research tends to develop fads, and at present endocrines, vitamins, and allergies are frequently called upon to explain conditions which are primarily constitutional, i.e., genetic, in origin. The alleged endocrine or allergic derangements may be secondary or in some cases they may not really enter the picture at all. The author emphasizes that the genotype or genic composition of the individual requires primary consideration in relation to any disease.

The Kretschmerian typology is used and references are made to its various synonyms. The association of pycnic physical type with cycloid temperament and of asthenic type with schizoid personality is attributed to the pleiotropic effects of particular genes. The further analysis of somatic types by Sheldon receives scanty attention.

Reference is made throughout the book to many inherited syndromes, the various apparently unrelated abnormalities of a syndrome being attributed either to several linked factors or to a single pleiotropic gene. In connection with arachnodactyly the author refers to one "case recently reported" in which dislocated lenses were also present. There are in fact many pedigrees in which these two conditions are more or less constantly associated. In such conditions as eunuchoidism and obesity the discussion is most enlightening from a genetical as well as a medical point of view. The author is skeptical about the endocrine basis of racial types, indicating the difficulties in applying this theory in detail to racial differences.

A useful conception which the author adopts is that of a locus minoris resistentiae or constitutional "weak spot." He cites numerous cases in which the biological inferiority (hypoplastic condition) of certain organs or glands is of genetic origin and determines the manner of development of a particular disease. That such weak spots are often familial is well known. Many instances of the inherited biological inferiority of particular organs and tissues are cited, including bones and joints, kidneys, heart, nervous system, thyroid, mesenchyme and ectoderm. Various types of abnormal constitution are considered, as well as the constitutional etiology of diabetes mellitus, hypertension, the anaemias, peptic ulcer and cancer.

The genome, the endocrine system and the nervous system are regarded as a triple safeguard. Any particular abnormal trait or function can be produced by abnormality in one or more of these systems. The book contains much of interest for those concerned with human biology in relation to constitution.

R. RUGGLES GATES,
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Woods Hole, Massachusetts

REVIEW

THE PRECENTRAL MOTOR CORTEX. Edited by PAUL C. BUCY. University of Illinois Press, Urbana, Illinois, xiv + 605 pp. 1944. ($4.50)

The scope of this exhaustive treatise on a limited part of the brain may best be conveyed by the title of the chapters which have been written by specialists in the field of neurology. Following a Foreword by John F. Fulton and an Introduction by the Editor, there follow articles on Architecture of the Precentral Motor Cortex and some Adjacent Areas, by Gerhardt von Bonin; The Role of Architectonics in Deciphering the Electoral Activity of the Cortex, by James L. O'Leary; Afferent Connections, by A. Earl Walker; Efferent Fibers, by Paul M. Levin; The Pyramidal Tract, by Sarah S. Tower; On Excitatory and Inhibitory Processes within the Motor Centers of the Brain, by N. Bubnoff and R. Haidenhain (a translation of a paper published in 1881); Cortico--Cortical Connections, by Warren S. McCulloch; Somatic Functions, by Margaret A. Kennard; Relationship to the Cerebellum, by Percival Bailey; Autonomic Functions, by Margaret A. Kennard; The Frontal Eye Fields, by Wilbur K. Smith; Electrical Excitability in Man, by Theodore C. Erickson; Effects of Extirpation in Man and Relation to Abnormal Involuntary Movements, by Paul C. Bucy; Clinical Symptomatology, by Charles D. Aring; Pathology, by Charles Davison; Significance of the Precentral Motor Cortex, by Marion Hines.

Of most interest to physical anthropologists is perhaps the paper by von Bonin which deals with the comparative morphology of the precentral motor cortex.

This region includes Brodmann's areas 4, 6 and 44 which have thalamocortical projections from the ventrolateral nucleus of the thalamus. New subdivisions not distinguished by Brodmann are recognized by von Bonin and of these 4a or FA of von Economo and Koskinas is found only in man. On the other hand area 44, which in man subserves with other areas the function of articulate speech, is found in all primate brains investigated. Area 8, the motor eye field, though not a part of the precentral motor cortex, is included because of its close cortical connections with it and especially the fact that it is a suppressor area influencing the region under discussion. But the interrelationship of the precentral motor cortex and other more remote areas of the brain are considered.

Von Bonin discusses the problem of the homologies of the cerebral sulci. A criterion of homology may exist in the relation of a sulcus, either limiting or axial, to a structural area of the brain. A limiting sulcus of an area varies in the preciseness with which it forms a boundary and there is a considerable shift in the position of the sulcus with respect to an area in the different groups of primates. From this it follows that sulci which are wholly different from a topographical point of view, are homologous when their relation to structural areas are regarded. Thus the prominent and constant inferior precentral sulcus forming a boundary between areas 6 and 44 in man, becomes homologous with the small anterior subcentral sulcus separating these areas in the chimpanzee.

The question of homologous sulci is a difficult one. There is obviously a fairly close relationship of many sulci to structural areas and yet no one would hesitate to identify a sulcus such as the inferior precentral in all primates irrespective of its position with regard to the areas.

There is, unfortunately, no complete agreement among morphologists on even naming the sulci much less on homologies. In some cases there may be doubt about the identity of certain sulci, but in general their identity is fairly well established and uniformity in terminology is then desirable. The oblique sulcus on the occipital lobe following the usage of Kappers, is called the superior occipital in the macaque (fig. 14) and the diagonal occipital in the chimpanzee (fig. 21). It would simplify matters if it were called the external or lateral calcarine in all primate brains, and the sulcus, being axial to the striate area, is furthermore homologous in the various groups. More difficult to identify with certainty is the sulcus opercularis of the frontal lobe, a continuation of the superior limiting sulcus of the insula, which is represented as a wholly isolated transverse furrow in the chimpanzee brain (fig. 21).

Significant is the fact of overlapping of functional representation. "No focus is exclusive for any one part of the body" states Doctor Erickson, "but rather represents, to a lesser extent it is true, many adjacent portions."

From ablation experiments on primates recorded in this volume, it is pointed out that the precentral motor cortex as well as other centers, are not functionally independent units, but are parts of a functioning whole.

This authoritative summary of the present status of knowledge regarding the precentral motor cortex will be of especial interest to the clinical neurologist and the neurophysiologist. For the student entering upon this highly specialized field of investigation, there is provided an excellent guide to the relevant literature.

C. J. Connolly,
The Catholic University of America

NOTES

NEW ANTHROPOLOGICAL PERIODICALS

The simultaneous appearance of two new and impressive anthropological periodicals from different schools of anthropology is indicative of the rapid growth of the science. Furthermore, since both new periodicals plan to include articles in all branches of anthropology, they may be attempting in some measure to counteract the present centrifugal trend in the science.

Physical anthropology and the recent president of the American Association of Physical Anthropologists are honored by being assigned to the lead-off position in the *Southwestern Journal of Anthropology:*

Franz Weidenreich — The brachycephalization of recent mankind.

The other six articles in the first number deal with cultural problems. Editor Leslie Spier, in this auspicious beginning, offers his journal as "a vehicle of expression for anthropologists in all parts of the world." Subscription is $4.00 a calendar year (single nos., issued quarterly, $1.00) and should be sent to the University of New Mexico Press, Albuquerque, New Mexico.

Acta Anthropologica is somewhat restricted in character, being intended as a publication medium for the Sociedad de Alumnos de la Escuela Nacional de Antropología of Mexico. Also, the planned individual numbers mostly will be devoted to single articles. Thus the first number is devoted to:

Miguel Acosta Saignes — Los Pochteca: Ubicación de los mercaderes en la estructura social Tenochca.

Physical anthropology will be represented in the first number of volume 2:

Johanna Faulhaber — Los tipos somáticos de la población indígena de México.

Subscription is $2.00 (American) per volume of 4 numbers (numbers vary in price) and should be sent to the editor, Sr. Fernando Jordán, Moneda 13, México, D. F.

NEW BIOMETRICS PERIODICAL

The Biometrics Section, which was formed within the American Statistical Association in 1938, began publishing a small *Biometrics Bulletin* in February of this year. This periodical is the third now published by the Association, the others being the Journal of the American Statistical Association and the ASA Bulletin. The new Bulletin, which contains brief articles, queries, news notes and abstracts, is intended to foster contacts between biologists concerned with statistical information, problems and methods, as well as to stimulate research and to elevate the standards of statistical work. The editorial committee, consisting of Gertrude M. Cox, chairman, C. I. Bliss, W. G. Cochran, F. R. Immer, H. W. Norton, L. J. Reed, G. W. Snedecor and Sewall Wright, expresses the hope that through this Bulletin the groundwork can be laid for a full-fledged biometrical journal at the end of the war.

The following articles in the first two numbers are of interest to physical anthropologists:

John R. Miner — Some uses of statistical methods in medicine (vol. 1, no. 1, pp. 3–5).

Th. Dobzhansky — Directly observable genetic changes in population of Drosophila pseudoobscura (vol. 1, no. 1, pp. 7–8).

Philip Levine — The geographical distribution of genes determining individual human blood differences (vol. 1, no. 2, pp. 20–21).

Single copies of the Biometrics Bulletin are 60 cents and annual subscriptions $3.00 (6 numbers). Subscriptions and applications for membership should be sent to the American Statistical Association, 1603 K Street, N. W., Washington 6, D. C.

THE BONY PELVIC GIRDLE IN EARLY INFANCY

A ROENTGENOMETRIC STUDY [1]

EARLE L. REYNOLDS

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SIX FIGURES

INTRODUCTION

This study is concerned with certain aspects of growth in the bony pelvis and hip. Serial roentgenograms, taken at regular intervals on ninety-five infants during the first postnatal year, provide materials for the investigation. Measurements made on these roentgenograms form the basis of analysis.

An attempt is made to answer, within the limitations of the data at hand and the methods employed, the following questions:

1. What is the growth pattern of the bony pelvis during the first year of life?
2. Are there demonstrable sex differences at this age?
3. What is the relation of pelvis structure, at this age, to body size and shape, to skeletal and tooth development, and to the age of walking?
4. Can a hereditary factor be seen in size and shape of the pelvis at birth?

The present study is the first in a projected series. A preliminary examination has already been made on a series of children between 2 and 8 years of age, most of the infants in the present study being included. When the records are available, a similar study is planned at the adolescent level. Finally, when these subjects, many of whom are already pubescent, have reached maturity, a final investigation of pelvic conformation and relationships will be made.

The longitudinal nature of the program at the Fels Research Institute makes such an undertaking feasible. The Institute, under the direction of Dr. L. W. Sontag, has been engaged for the past 14 years in an intensive study of human growth and development. The writer takes this opportunity to thank the director for his permission to use the material, and for his generous advice and assistance.

[1] These data formed a portion of a PhD. thesis, written for the Department of Anthropology, University of Wisconsin.

LITERATURE

The literature on the human pelvis is extensive, but there are relatively few studies dealing with the period of infancy. Roentgenologic studies of this period are even more scarce. Morrison ('32), in a discussion of the development of the normal hip as interpreted by the roentgenologist, shows a series of roentgenograms of the infant hip. Burman and Clark ('40) have made a roentgenologic study of the hip-joint in thirty-four infants during the first year, which is descriptive and clinical in nature. Other clinical studies, especially those concerned with congenital dislocation of the hip, have employed roentgen diagnosis. To the writer's knowledge, no roentgenometric studies of the infant pelvis have been made.

Roentgenologic observations on the fetal pelvis are somewhat more numerous. Relevant aspects of such studies are important, since birth, the end-point of fetal studies, is the earliest age-level in the present investigation. The work of Hess ('17), Adair ('18), Pryor ('23) and Flecker ('32, '42) may be particularly cited. Outstanding contributions of these and other workers include: determination of the normal time of appearance of various primary ossification centers; demonstration that the female is generally earlier than the male in onset of ossification, and the male generally larger than the female in size of pelvis at birth; and a general description of fetal pelvic development.

However, most investigations to date have been based on observations of collections of pelves, both fetal and postnatal, or on anthropometry.

Two major problems have occupied the attention of most workers in this area. These have been well summarized by Moloy: "The first deals with the presence or absence of sexual differences in the pelvis of the fetus, infant, or child; the second concerns the changes in the morphology of the pelvis produced by growth and development quite distinct from the sexual characteristics in pelves." (Morton, '42, p. 818).

The question of the existence of prepubertal sex differences has been a subject of considerable controversy. Many observers have claimed that sex differences in the pelvis could be distinguished during fetal life. Fehling (1876), from a study of 130 fetal pelves, believed that sex differences could be seen as early as the fourth fetal month. Thomson (1899), from an examination of eight fetal pelves, reached the same conclusion. Later workers have tended to confirm these findings, and this viewpoint has found its way into many texts, including Scammon (in Abt, '23), Martin ('28), Adair (in Curtis, '34) and Williams (in Stander, '41).

Yet this conclusion has by no means been universally accepted. Konikow (1894), in external measurements taken on 120 cases, could find no prepubertal sex differences. Ariëns Kappers ('38), in a study of fifty-three fetal pelves, says: ". . . characteristic sexual differentiation of the adult pelvis cannot be pointed out in any other period of ontogenesis, not even at the end of the prenatal period, as other authors have supposed." (Author's summary, Biol. Abst., vol. 13, p. 2452.)

A recent paper by Yamamura ('39) on 140 fetuses obtained from hospitals in Kyoto in 1936, does not favor the belief in the existence of prenatal sex differences in the pelvis. Still more recently Morton ('42), in a study of twenty-seven fetal pelves, could find few fetal sex differences. In roentgenographic observations on 143 children from 3 to 18 years, Morton and Hayden ('41) and Morton ('42) reported only two possible sex differences before puberty, a shorter posterior segment of the inlet in the male, and a downward angulation of the sacrum in the male.

This disagreement of later observers with earlier opinion seems to reopen the question of the genesis of sex differences in the pelvis.

Specific growth changes in the pelvis during the first postnatal year have been less fully explored. Certain differences between the newborn pelvis and that of the adult are described in standard texts, but the charting of the progress of change in early infancy has not been completely carried out. Scammon (in Abt, '23) says, "During the first two years of life the pelvis grows rapidly in all dimensions" (p. 278). Similar observations by other writers have laid out the general plan of development; a more detailed examination of the growth process in infancy seems justified.

That a knowledge of pelvic development is not of academic interest only is realized by Williams:

"The mechanism by which the pelvis of the fetus is converted into the adult form is of interest, not only from a scientific, but also from a practical, point of view, as it affords important information concerning the mode of production of certain varieties of deformed pelves." (Stander, '41, p. 284.)

THE ROENTGENOLOGIC PELVIS

The roentgenologic pelvis of the infant is quite distinctive. At birth, a pelvic roentgenogram ordinarily shows ossification in the superior pubic ramus, the inferior ramus of the ischium, and much of the body of the ilium. These make up the ultimate os innominatum after the appearance of the secondary centers. The sacrum at birth may be seen

in the roentgenogram as a series of scattered nuclei. Only the osseous portion of the pelvis is discernible in the ordinary roentgenogram, and it is this portion (excluding the sacrum) which is studied in the present paper.

Measurements taken upon a roentgenogram possess both advantages and limitations peculiar to its nature. The film is a permanent record and measurements may be checked and referred to at any time. Bad positioning is at once apparent, and the offending film may be discarded. Measurements unavailable from any other source may be taken on the living. The technique is admirably suited to longitudinal studies of growth. On the other hand, certain limiting factors must be considered.

Distortion. Radiographic distortion is a factor in all roentgenograms. It may be defined as the magnification of the size of an object due to the projection of its image onto the roentgenographic film. The divergence of the rays from a central source is the causal factor involved. The amount of such distortion can be calculated if certain spacial relations are known (Files, '44, p. 91). In the present study, the radiographic distortion, as determined from a small series, ranges from less than 3% in birth films to about 6% in 12-month films. This factor does not affect the objectives of the present investigation, but its presence should be known. Campbell and Rubenstein ('37), in their article on roentgen anthropometry and pelvimetry, have given a further discussion of this subject.

The relation of roentgenometric to anthropometric measurements. It should be pointed out that the enlargement of a part due to radiographic distortion introduces less error, when dealing with infants, than do the various disturbing elements entering into anthropometry. When the pelvic breadth of the infants in the present series is determined by both methods, two facts are apparent: The curves defined by the anthropometric and the roentgenometric means are parallel; and the anthropometric value is, in each case, larger than the roentgenometric value. This difference has been discussed by others, including Ritt and Sawtell ('30).

The difference is not merely a matter of averages, but is consistent upon inspection of the individual children. Without exception, the value obtained from direct measurement of an infant was larger than the value obtained from the roentgenogram, and this despite the known magnification of the latter. It seems reasonable to say, therefore, that since the roentgenometric measurement is known to be larger than the true dimension, and yet is smaller than the corresponding anthropo

metric measurement, roentgenometry appears to be the more reliable method, at this age-level.[2]

The larger measurements derived from anthropometry are explained by the difficulty in locating the bony landmarks, the active resistance of the subject, and particularly by the soft-tissue covering of the bones, all combining to make accurate bi-iliac measurements on young infants difficult values to obtain. These difficulties are partly overcome at older age-levels, and the expected excess of the uncorrected roentgenometric over the anthropometric measurement may then be seen (unpublished data).

The classification of measurements. Measurements taken from an anteroposterior roentgenogram, when considered in relation to the actual measurements on the pelvis, may be put into two groups.

First, there are measurements which are essentially the same as the dimensions of the part itself. Such values are determined by points on the bony pelvis which are approximately equidistant from the photographic plate, the line defining the measurement thus being parallel to the film. Transverse and, for practical purposes, the overall height measurements of the pelvis fall into this class. Such items will be defined and discussed later as group A measurements.

On the other hand, any inspection of a lateral roentgenogram of an infant pelvis will show that certain parts of the bony pelvis do not lie parallel to the film. The ischium is a good example. The measurement of the length of the ischium, therefore, as taken from an anteroposterior roentgenogram, will give a value which is not comparable, even with normal radiographic distortion considered, to the actual length of the bone.

Such measurements have no direct counterpart in non-roentgenologic studies. They are roentgenologic "abstractions," and must be recognized as such. Anatomically considered, they are usually sagittal or oblique in nature, and cannot be employed, without correction, for determinations of the actual size of a part. Their value in a roentgenologic study depends upon the use to which they are put. For the objectives of the present study, as the writer will try to show, they are quite suitable, and are described later as group B measurements.

The distinctions between these two classes of measurements lies in the interpretation of differences found between individuals and between groups. A significant difference in group A measurements must be

[2] The r between the two methods is $+ .75$ at birth and $+ .81$ at 1 month. Reynolds and Hooton ('36), in a similar comparison on adults, found: for sixteen males, $+ .76$; for twenty-four females, $+ .87$.

interpreted differently than a significant difference in group B measurements. Such distinctions will be discussed more fully in the final section of the paper.

MATERIAL AND METHOD

The sample. The forty-six boys and forty-nine girls in the present study had 467 sets of roentgenograms taken during the first postnatal year. The subjects, white babies born in southwest central Ohio, are participants in the intensive long-term study of growth and development conducted by the Samuel S. Fels Research Institute. Fels infants are x-rayed at birth and at 1, 3, 6, 9 and 12 months of age. It is thus possible for an individual infant to have as many as six sets of roentgenograms taken by the end of the first postnatal year (570 possible sets for the group). The distribution of cases, by number of roentgenograms taken, is shown in table 1.

TABLE 1

Distribution of infants by number of roentgenograms taken on each.

SEX	NUMBER OF ROENTGENOGRAMS TAKEN						NUMBER OF INFANTS
	6	5	4	3	2	1	
Boys	26	5	5	6	1	3	46
Girls	24	12	4	3	3	3	49
Total infants	50	17	9	9	4	6	95

TABLE 2

Distribution of cases by roentgenograms available at each age-level.

SEX	AGE IN MONTHS						NUMBER OF ROENTGENOGRAMS
	Birth	1	3	6	9	12	
Boys	46	39	37	38	31	33	224
Girls	49	39	42	43	36	34	243
Total cases	95	78	79	81	67	67	467

It will be seen that the majority of the infants have their full complement of six roentgenograms each, while 90% have three or more. When the cases are separated by age-level and sex, in table 2, a reasonably large representation is available for analysis, no category having fewer than thirty cases.

Most of the birth films were made on the day of birth or very shortly thereafter; none was made later than 7 days after birth. Films for the upper age-levels were with rare exceptions taken either on or within a day or two of the scheduled time. The birth films are torso roentgeno-

grams, taken at the hopsital, at a 36-inch focal-film distance. The films taken at the other age-levels are centered to the left hip, from the same distance. In all cases the infant was supine, and the method of handling as standardized as is possible at this age. Films showing gross positioning defects were discarded.

Careful tracings were made of all films. The shadows of the bony ilium, ischium and pubis on both sides were traced at birth and 1 month. At these two age-levels, the bony portions of the pelvic girdle were thus defined. At the upper age-levels, the left side only was traced. The present study will confine itself to conclusions derived from measurements taken on these tracings.

The measurements. In the previous section, mention was made of the fact that certain measurements, because of their symmetrical position within the body, were essentially similar to the same measurements taken directly on the pelvis. These are described in group A. Those measurements which are roentgenologic in nature, rather than anatomic, have been put in group B. This does not mean that one set of measurements, for the purposes of the present paper, is to be considered as having more usefulness than the other set. It is a distinction made for convenience in interpretation and treatment.

Considerations guiding the choice of measurements included: representativeness, validity and reliability, and conformity to previous studies. The bony pelvis is of course much less irregular in shape during infancy than in maturity, and many linear measurements, not feasible at older age-levels, may be taken on the infant pelvis.

The following measuremnts were taken from the tracings:

GROUP A

ITEM	DESCRIPTION
Pelvis height	The maximum distance between the upper edge of the iliac crest and the lower margin of the ischium, taken on the left side. All ages.
Pelvis breadth	The maximum transverse distance between the outer borders of the iliac crests; corresponds to the bi-iliac. Birth and 1 month.
Inlet breadth	The maximum transverse diameter of the inlet. Birth and 1 month.
Inter-iliac breadth	The minimum distance between the ilia. Birth and 1 month.
Inter-pubic breadth	The minimum distance between the pubic bones. Traverses the area of the pubic symphysis. All ages.
Bi-ischial breadth	The minimum distance between the ischia. All ages.
Ilium length	The maximum length of the ilium, along its long axis. Left side; all ages. Intermediate in nature.
Pubis length	The maximum length of the pubis, along the shaft. Left side; all ages. Intermediate in nature.

GROUP B

Inlet, sagittal diameter	The anteroposterior distance between the centers of a lin joining the posterior borders of the greater sciatic notch, an the center of a line defining the posterior surface of the pubi symphysis. Birth and 1 month.
Ilium breadth	The maximum breadth of the ilium, at right angles to th length. Left side; all ages.
Ischium length	The maximum length of the ischium along the shaft. Lef side; all ages.
Breadth of greater sciatic notch	The breadth of the sacro-iliac notch, insofar as it is, at thes age levels, contained entirely within the ilium. Left side; a ages.

All the measurements in groups A and B are illustrated in figure 1 From these values, the following indices were calculated:

ITEM	DESCRIPTION
Pelvic index	$\frac{\text{Pelvis height}}{\text{Pelvis breadth}} \times 100$. Birth and 1 month.
Inlet index	$\frac{\text{Inlet, sagittal diameter}}{\text{Inlet breadth}} \times 100$. Birth and 1 month.
Iliac index	$\frac{\text{Ilium breadth}}{\text{Ilium length}} \times 100$. All ages.
Sacral index	$\frac{\text{Inter-iliac breadth}}{\text{Pelvis breadth}} \times 100$. Birth and 1 month. This item i called "sacral index" because it represents approximately th relative breadth of the sacral region.
Relative inlet breadth	$\frac{\text{Inlet breadth}}{\text{Pelvis breadth}} \times 100$. Birth and 1 month.
Anterior segment index	$\frac{\text{Inlet, sagittal diameter}}{\text{Anterior segment}} \times 100$. Birth and 1 month. The an terior segment is that portion of the sagittal diameter of th inlet that lies in front of the greatest transverse diameter o the inlet.

It will be noted that on all paired measurements, the left side was taken as representative. This was done after measurements had been made at birth on the right side as well, and a test of the differences be tween sides showed no significant differences. The question of pelvic asymmetry, on which some work has been done in the past, and which becomes an interesting problem in older age-levels, was not treated in the present study.

The above measurements and indices were subjected to standard statistical analysis, to be described in its proper place, in order to

bring out salient information concerning growth changes and patterns, sex differences, structural and functional relationships, and hereditary aspects. All measurements and calculations were checked.

Finally, it should be pointed out that a reference to an item such as pelvis height is merely a convenient way of saying "height of the shadow of the pelvis on the roentgenogram, as measured according to the description given."

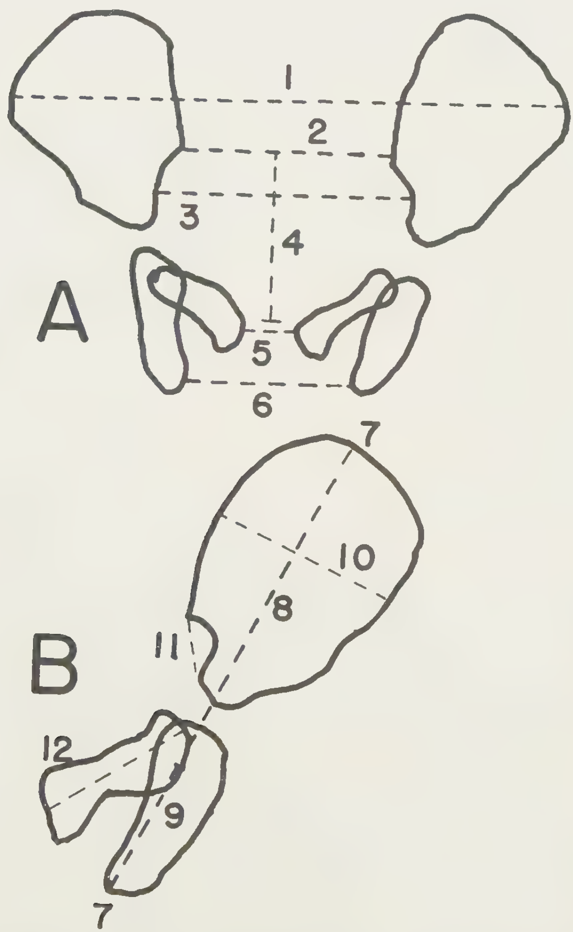

Fig. 1 The measurements, as taken from a pelvic tracing (A) and a hip tracing (B). In (A): 1, pelvis breadth; 2, inter-iliac breadth; 3, inlet breadth; 4, sagittal inlet, diameter; 5, inter-pubic breadth; 6, bi-ischial breadth. In (B): 7, pelvis height; 8, ilium length; 9, ischium length; 10, ilium breadth; 11, breadth of sciatic notch; 12, pubis length.

RESULTS

1. *Growth changes in the pelvic girdle from birth through 1 year*

Intercorrelations of measurements at birth. The twelve basic meas urements were intercorrelated (Pearson *r*) at birth, for boys and girl separately, and the sexes combined according to the z-method of Fishe ('32, p. 183). In general, the sexes tend to behave in the same fashion certain sex differences of interest will be discussed in the next sectior The intercorrelation coefficients, for the sexes combined, are shown i table 3.

TABLE 3

Intercorrelation of twelve basic measurements at birth, sexes combined.[1]

		B	C	D	E	F	G	H	I	J	K	L
A	Pelvis height	77	74	54	02	24	80	36	33	24	75	4[illegible]
B	Pelvis breadth		86	62	18	17	72	54	41	34	59	3[illegible]
C	Inlet breadth			71	34	13	45	48	46	31	58	4[illegible]
D	Inter-iliac breadth				29	44	50	29	38	08	45	2[illegible]
E	Inter-pubic breadth					14	20	— 05	23	31	— 06	1[illegible]
F	Bi-ischial breadth						32	24	28	06	— 02	2[illegible]
G	Ilium length							46	66	05	58	4[illegible]
H	Pubis length								48	20	52	3[illegible]
I	Inlet, sagittal diameter									37	06	8[illegible]
J	Ilium breadth										16	4[illegible]
K	Ischium length											3[illegible]
L	Breadth of sciatic notch											

[1] Decimal points omitted. Coefficients positive unless indicated.

Between eighty and ninety paired items went into each coefficien For eighty pairs, an *r* of 0.28 is considered highly significant (Guilforc '36, p. 549) ; that is, there is less than one chance in a hundred that suc a value could be obtained from the correlation of two groups betwee which no real relationship exists. In table 4, all coefficients of 0.28 an over are so indicated.

Inspection of table 4 shows that certain values tend to show a con siderable degree of intercorrelation. These measurements includ pelvis height, pelvis breadth, inlet breadth, inter-iliac breadth, iliur length, pubis length, sagittal inlet, ischium length and breadth of sciati notch. All these items show a highly significant intercorrelation pat tern, with two exceptions: sagittal inlet and ischium length (+ .06) and inter-iliac breadth and breadth of sciaitc notch (+ .22).

Three measurements do not fall within this highly intercorrelate group: inter-pubic breadth, bi-ischial breadth and ilium breadth.

If intercorrelation "syndromes" are constructed, along the lines suggested by Sanford et al. ('43), and a coefficient of + .50 or more set up as an arbitrary boundary, two sub-groups emerge.

The first grouping, which might be called a "Group A Syndrome," includes: pelvis height, pelvis breadth, inlet breadth, inter-iliac breadth, ilium length and ischium length. These six values show intercorrelations of at least + .50, with only two exceptions: inlet breadth and ilium length (+ .45); and inter-iliac breadth and ischium length (+ .45). A child who has a high value in one of these items will tend to have a high value in the other five as well, although this does not, of course, intimate that such a combination is invariably found.

TABLE 4

Correlation coefficients (r of + .28 and over) significant of the 1% level.[1]

		B	C	D	G	H	I	K	L	E	F	J
A	Pelvis height	x	x	x	x	x	x	x	x			
B	Pelvis breadth		x	x	x	x	x	x	x			x
C	Inlet breadth			x	x	x	x	x	x	x		x
D	Inter-iliac breadth				x	x	x	x		x	x	
G	Ilium length					x	x	x	x		x	
H	Pubis length						x	x	x			
I	Inlet, sagittal diameter								x		x	x
K	Ischium length								x			
L	Breadth of sciatic notch											x
E	Inter-pubic breadth											x
F	Bi-ischial breadth											
J	Ilium breadth											

[1] Order re-arranged so as to group interrelated variables.

The second grouping, which might be called a "Group B Syndrome," includes three items: sagittal inlet, breadth of sciatic notch and ilium length (the latter two having a coefficient of + .48).

Ilium length is the connecting link between the two syndromes. Ischium length, which is a group B item, nevertheless falls in with group A in terms of intercorrelation.

The problem arises as to why these differentials in intercorrelation appear. Viewed structurally, measurements of the pelvis might be placed in four categories: over-all measurements, measurements of individual bones, measurements of spaces controlled primarily by surrounding bones, and measurements controlled by multiple factors. In table 5, the twelve measurements are ranked from highest to lowest in terms of their intercorrelating effectiveness, while at the same time both their group position (A or B) and this somewhat arbitrary structural classification are indicated.

An inspection of table 5 indicates that it is not the group category but the structural type, that is related to the efficiency of a measurement as an intercorrelating variable. That is to say, a value such as sagittal inlet, which in this study is a roentgenological "abstraction" in that it does not measure the true anteroposterior diameter of the inlet, nevertheless is a very useful tool, if its close association with more standard measurements is a criterion. On the other hand, a measurement such as bi-ischial breadth, a group A item, approximating the same value in the skeleton, shows little tendency to be intercorrelated with other items. It is possible that bi-ischial breadth is a value which is not anchored down, as it were. It is affected by a number of interfering factors, including the growth of either or both of the ischia, their plane of inclination in the body, slight postural shifts, and the growth of the pelvis as a whole.

TABLE 5

The relation of effectiveness of intercorrelation to type of measurement.

ITEM, RANKED IN ORDER OF EFFECTIVENESS OF INTERCORRELATION	GROUP	STRUCTURAL TYPE
Inlet breadth	A	Controlled space
Inlet, sagittal diameter	B	Controlled space
Pelvis breadth	A	Overall size of pelvis
Inter-iliac breadth	A	Controlled space
Ilium length	A-B	Individual bone
Breadth of sciatic notch	B	Controlled space
Pelvis height	A	Overall size of pelvis
Pubis length	A-B	Individual bone
Ischium length	B	Individual bone
Ilium breadth	B	Individual bone
Inter-pubic breadth	A	Multiple factors
Bi-ischial breadth	A	Multiple factors

The above statements, while admittedly speculative, offer at least one possible explanation of the differentials which exist in intercorrelation patterns. Following this reasoning, it may be said that measurements controlled directly by surrounding structures and over-all measurements are in the higher intercorrelation levels, followed closely by measurements defining individual bony elements; while measurements which are dependent for their value upon a number of interfering factors show the least tendency to be intercorrelated with other items.

In general, taking into consideration the structural type of measurement involved, a quite high correlation pattern exists between measurements taken at birth. Forty-four out of sixty-six paired items show a highly significant correlation coefficient. Nine of the twelve basic

measurements are significantly intercorrelated. Two syndrome patterns (r of $+ .50$ and higher) can be seen; one with six items, related to general pelvic conformation; one with three items, related mainly to anteroposterior dimensions of the inlet.

Growth norms and growth curves for the first postnatal year. Tables 6 and 7 present means, standard deviations, and coefficients of variation for the various items, by age and by sex.

There is a fairly wide range in the size of the bony pelvis at birth. This is shown in figure 2, in which the tracings of the smallest and the largest birth pelves, for each sex, are shown. The tracings are reduced to one-half their actual size as taken from the roentgenogram. The smaller of the boys' set represents one of a pair of twins, birth weight 4 pounds.

It is evident that any cross-sectional growth study which does not contain a sufficient series to cover adequately at least the range in size as here shown, can make only tentative conclusions concerning growth changes and sex differences. For example, if a study employing only a small series of pelves should, through the vagaries of sampling, obtain boys' pelves from the smaller end of their size range, and the girls' pelves from the larger end of their size range, a somewhat biased picture might be obtained of size and sex differences in the pelvis at birth.

The pelvis grows fastest between birth and 3 months, during the first year of life. The rate of growth progressively decelerates from 3 months to 1 year. This can be seen in the growth curves shown in figure 3 for pelvis height, ischium length and pubis length, and in figure 4 for ilium length and breadth.

The growth curves for boys and girls tend to run a parallel, but not always an identical, course. The extent and significance of sex differences will be discussed in the next section.

The iliac index (fig. 4) shows a sharp rise from birth to 1 month, and then tends to fall slowly, rising again slightly between 9 months and 1 year, at which time it again approximates its birth value. Thus, the ilium tends to be relatively broader for its length at 1 month than at any other age-level studied.

Figure 5 presents curves for the breadth of the sciatic notch and the inter-pubic breadth. The sciatic notch shows a rise at 1 month, a drop to approximately the birth value at 3 months, and then a slow rise to 1 year. The inter-pubic breadth shows little change during this period of growth. The tendency for the value to become smaller, which would be an expression of the growth of the pubic bones, is presumably

TABLE 6

Means, standard deviations (S.D.) and coefficients of variation (C.V.) for eight pelvic items from birth through 1 year.

AGE	BOYS				GIRLS			
	n	Mean	S.D.	C.V.	n	Mean	S.D.	C.V.
			Pelvis height (mm.)					
Birth	46	56.1	3.3	5.9	49	55.7	3.2	5.7
1 month	37	61.8	3.4	5.5	38	61.1	3.0	4.9
3 months	36	72.9	3.2	4.4	40	70.8	3.9	5.5
6 months	36	82.8	3.5	4.2	37	80.5	3.8	4.7
9 months	28	89.9	3.5	3.9	31	87.6	4.1	4.7
12 months	29	94.9	3.9	4.1	30	92.7	4.0	4.3
			Inter-pubic breadth (mm.)					
Birth	46	7.2	1.6	22.2	48	7.7	1.8	23.3
1 month	37	7.6	1.3	17.0	39	8.2	1.1	13.5
3 months	34	8.5	1.3	15.3	40	8.4	1.4	16.6
6 months	32	8.6	1.6	18.6	36	8.1	1.7	21.0
9 months	30	8.3	1.2	14.5	24	8.1	1.4	17.2
12 months	24	7.8	1.7	21.7	23	7.6	1.6	21.0
			Ilium length (mm.)					
Birth	46	32.4	2.4	7.4	49	32.9	2.1	6.4
1 month	39	36.0	1.9	5.3	39	36.1	2.0	5.5
3 months	36	41.3	1.9	4.6	41	40.7	2.4	5.9
6 months	36	47.2	2.3	4.9	38	46.4	2.7	5.8
9 months	28	51.9	2.3	4.4	31	51.6	2.9	5.6
12 months	29	54.5	2.8	5.1	30	54.3	2.6	4.8
			Ilium breadth (mm.)					
Birth	46	22.4	3.6	16.0	49	22.6	3.8	16.8
1 month	39	26.4	3.1	11.8	39	25.1	3.5	13.9
3 months	36	29.2	3.6	12.3	42	27.1	4.4	16.2
6 months	36	33.1	4.2	12.7	39	31.1	5.2	16.7
9 months	29	35.8	4.8	13.4	32	33.3	6.3	18.9
12 months	30	38.0	5.1	13.4	31	36.1	6.7	18.6
			Ischium length (mm.)					
Birth	46	19.6	1.5	7.6	49	19.7	1.6	8.1
1 month	37	22.0	1.9	8.6	38	22.3	1.5	6.7
3 months	37	26.8	1.8	6.7	41	26.7	2.1	7.9
3 months	38	30.8	2.0	6.5	38	31.0	2.0	5.8
9 months	31	34.2	2.2	6.4	36	34.4	2.0	5.8
12 months	33	36.7	1.9	5.2	34	36.6	1.7	4.6
			Pubis length (mm.)					
Birth	39	15.6	1.8	11.5	44	16.7	2.0	12.0
1 month	37	18.6	1.6	8.6	39	18.8	1.3	6.9
3 months	37	22.0	1.7	7.7	42	22.0	1.4	6.3
6 months	38	25.6	2.0	7.8	41	25.8	1.7	6.6
9 months	30	28.7	2.4	8.4	34	28.6	1.9	6.6
12 months	32	30.6	1.9	6.2	31	30.4	1.9	6.3
			Breadth of greater sciatic notch (mm.)					
Birth	46	9.0	1.6	17.8	48	10.0	1.9	19.3
1 month	39	10.6	2.0	18.5	39	11.2	1.8	16.2
3 months	37	9.8	1.8	18.1	42	10.7	2.4	22.3
6 months	38	11.3	2.2	19.6	42	11.4	2.9	25.4
9 months	31	13.5	2.7	19.7	35	14.1	3.0	21.6
12 months	31	14.0	2.9	20.9	32	14.7	2.3	15.9
			Iliac index					
Birth	46	69.3	10.7	15.4	49	68.8	11.3	16.4
1 month	39	72.7	8.0	11.0	39	69.5	8.2	11.8
3 months	36	70.7	8.3	11.7	41	66.8	10.0	15.0
6 months	36	70.3	9.2	13.1	38	66.7	10.5	15.7
9 months	28	69.1	9.2	13.3	31	65.2	11.0	16.9
12 months	29	70.0	9.3	13.3	30	67.4	12.0	17.8

balanced by the over-all growth of the pelvis, which tends to widen the symphyseal area.

The coefficient of variation. The coefficient of variation is in most cases higher at birth than at the older age-levels. Whether this is a biologic characteristic or an artifact due to more variable positioning at birth is not clear. In general, the coefficient tends to be fairly low (5% to 10%), rising in items which show immediate response to slight changes in positioning, as ilium breadth, and in items of low magnitude, as inter-pubic breadth. The sexes, although tending to show the same fluctuations, have certain differences, which will be discussed later.

TABLE 7

Means, standard deviations (S.D.) and coefficients of variation (C.V.) for ten pelvic items, at birth and 1 month.

ITEM	Birth n	Birth Mean	Birth S.D.	Birth C.V.	1 month n	1 month Mean	1 month S.D.	1 month C.V.
BOYS								
Pelvis breadth	45	75.8 mm.	4.9	6.5	38	83.6 mm.	4.5	5.4
Inlet, sagittal	44	22.3 mm.	3.2	14.3	36	25.1 mm.	2.5	10.0
Inlet breadth	45	37.0 mm.	2.4	6.5	38	40.4 mm.	2.5	6.2
Inter-iliac br.	45	27.6 mm.	2.9	10.5	38	30.4 mm.	2.4	7.9
Bi-ischial br.	46	21.9 mm.	2.4	10.8	36	22.3 mm.	2.1	9.6
Pelvic index	45	74.3%	2.8	3.8	36	74.0%	2.4	3.2
Inlet index	44	60.2%	7.2	12.0	36	62.4%	6.4	10.3
Sacral index	45	36.4%	3.1	8.5	38	36.4%	2.8	7.7
Relative inlet br.	45	48.9%	1.7	3.5	38	48.4%	1.9	3.9
Anterior segm. ix.	44	125.4%	10.0	8.0	36	124.2%	6.6	5.3
GIRLS								
Pelvis breadth	49	74.4 mm.	4.7	6.3	39	81.6 mm.	4.7	5.8
Sagittal inlet	47	23.0 mm.	2.9	12.6	39	25.2 mm.	3.0	11.9
Inlet breadth	48	36.8 mm.	2.5	6.8	39	40.2 mm.	2.2	5.5
Inter-iliac br.	49	26.9 mm.	2.6	9.7	39	30.0 mm.	1.7	5.7
Bi-ischial br.	49	23.1 mm.	2.8	12.3	37	23.5 mm.	2.9	12.5
Pelvic index	49	74.9%	3.6	4.8	38	74.9%	2.9	3.9
Inlet index	47	62.9%	7.8	12.4	39	62.8%	7.6	12.1
Sacral index	49	36.1%	2.8	7.8	39	36.9%	2.1	5.7
Relative inlet br.	48	49.6%	2.0	4.0	39	49.2%	1.6	3.2
Anterior segm. ix.	47	127.3%	8.2	6.4	39	130.0%	11.4	8.8

The relation of birth values to values at 1 year of age. It may be of interest to examine the relationship of measurements taken at birth to those same measurements taken on the same children at the age of 12 months. Such a comparison will give some idea of the extent to which a birth value tends to maintain its position in the same series, at an older age-level. The amount of such an association, as shown by the

coefficient of correlation (r), is shown in table 8, for those items having both a birth and a 12-month value.

Approximately sixty pairs of comparisons went into each coefficient. The sexes were calculated separately, and grouped when they showed approximately the same behavior. For a series of this size, a coefficient of + .32 may be considered very significant (1% level).

Using + .32 as the critical point, birth size and size at 12 months are very significantly associated for pelvis height, ilium length, ischium length and pubis length. For the other two items, ilium breadth and

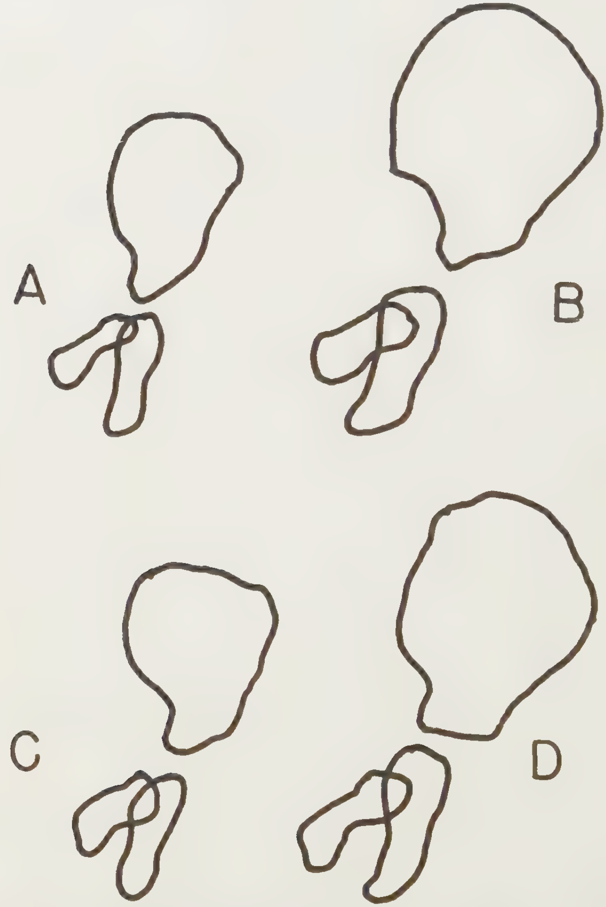

Fig. 2 Extremes in size of pelvis at birth. For simplicity, only left side shown. A, the smallest pelvis in the males' series; B, the largest pelvis in the males' series; C, the smallest pelvis in the females' series; D, the largest pelvis in the females' series.

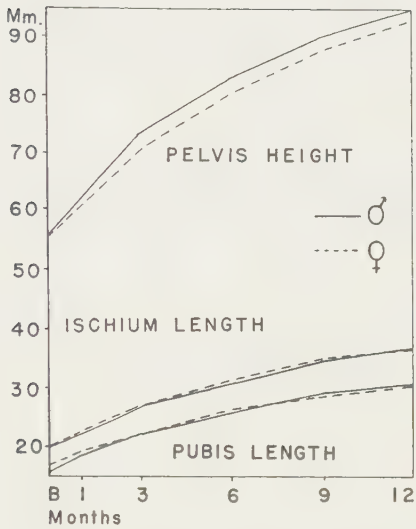

Fig. 3 Growth curves for pelvis height, ischium length and pubis length.

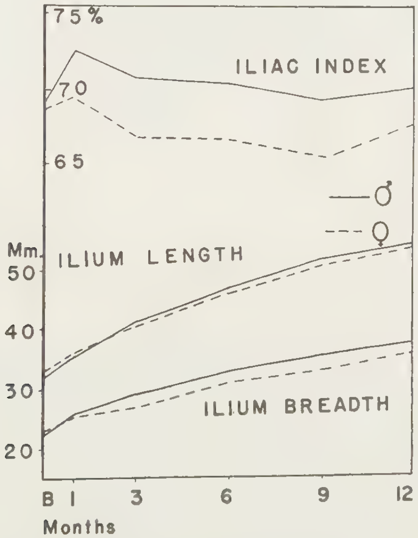

Fig. 4 Growth curves for iliac index, ilium length and ilium breadth.

breadth of sciatic notch, there is no evidence from this source that the value at birth bears any significant relationship to the value of that same item for the same child at 12 months.

2. *Sex differences in the bony pelvis and hip in the first year*

Sex differences in pattern of intercorrelation. Mention was made in the previous section that certain sex differences in the intercorrelation pattern would be examined. Table 9, using + .40 as the point of significance, indicates which items are significantly correlated for both sexes, and which items are significantly correlated for only one sex. Table 10 tabulates these findings in a somewhat different form.

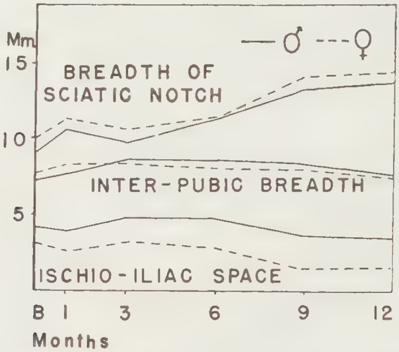

Fig. 5 Growth curves for breadth of sciatic notch, inter-pubic breadth and ischio-iliac space.

TABLE 8

The coefficient of correlation (r) between size of a part at birth and size at 12 months.

ITEM	*r*
Pelvis height	+ .62
Ilium length	+ .38
Ilium breadth	+ .04
Ischium length	+ .75
Pubis length	+ .40
Breadth of greater sciatic notch	+ .02

Seventeen pairs of items show a significant correlation for both sexes. In addition, the boys show a significant association in another fifteen pairs, and the girl in another eight pairs.

The boys tend to show higher correlation coefficients in pelvis breadth, inlet breadth, inter-iliac breadth, pubis length, sagittal inlet and ilium breadth. The girls lead in pelvis height and bi-ischial breadth.

The tendency toward higher correlations among the boys can also be demonstrated in somewhat crude fashion by comparing arithmetic means of the sixty-six coefficients obtained for each sex. The mean *r* for boys is .407, for girls, .355.

TABLE 9

Significant (r of + .40 and over) correlations of basic measurements, by sex.[1]

		B	C	D	E	F	G	H	I	J	K	L
A	Pelvis height	x	x	x			x	F			x	F
B	Pelvis breadth		x	x			x	M	M	M	x	M
C	Inlet breadth			x			F	M	M	M	x	x
D	Inter-iliac breadth				M	F	M	M			M	
E	Inter-pubic breadth											
F	Bi-ischial breadth						F		F			
G	Ilium length							F	x		x	M
H	Pubis length								M	x	M	
I	Inlet, sagittal diameter									M		x
J	Ilium breadth											x
K	Ischium length											F
L	Breadth of sciatic notch											

[1] x indicates both sexes over + .40; M, males over + .40; F, females over + .40.

TABLE 10

Sex differences in intercorrelations of individual measurements.

ITEM	NUMBER OF SIGNIFICANT CORRELATIONS			
	Both sexes	Boys only	Girls only	Total
Pelvis height	5	0	2	7
Pelvis breadth	5	4	0	9
Inlet breadth	5	3	1	9
Inter-iliac breadth	3	4	1	8
Inter-pubic breadth	0	1	0	1
Bi-ischial breadth	0	0	3	3
Ilium length	4	2	3	9
Pubis length	1	5	2	8
Inlet, sagittal diameter	2	4	1	7
Ilium breadth	2	3	0	5
Ischium length	4	2	1	7
Breadth of sciatic notch	3	2	2	7
Totals	34	30	16	80

Sex differences in measurements and indices. Figures 3, 4 and 5 show that, although the shapes of the growth curves are essentially the same for boys and girls, these curves do not always coincide, but tend to run parallel courses. This is well shown in the case of pelvis height (fig. 3), in which the boys consistently show a greater value than the

girls. This difference is statistically significant at 3, 6, 9 and 12 months.[3]

All norms have been tested for the statistical significance of the differences between boys and girls, holding the age-levels constant, and the results, as expressed in terms of the critical ratio, are shown in table 11. Critical ratios of less than 1.0 are not recorded.

For series of the size used, a critical ratio of 2.0 or more indicates a difference that is significant at the 5% level or lower; that is, a difference as large as this could be expected to occur by chance less than five times in a hundred (Guilford, '36, pp. 62, 548). The items which show such significant differences are shown in table 12.

TABLE 11

Critical ratios (1.0 and higher) of differences between means of boys' and girls' measurements.

ITEM	AGE-LEVEL, MONTHS					
	Birth	1	3	6	9	12
Pelvis height		. .	2.6[1]	2.7[1]	2.3[1]	2.1[1]
Pelvis breadth	1.3[1]	1.9[1]	. .	. .	. .	. .
Inlet breadth						.
Inter-iliac breadth	1.2[1]	. .	. .	. .	. .	. .
Inter-pubic breadth	1.5	1.8	. .	1.3[1]		. .
Bi-ischial breadth	2.2	2.0	. .	. .		. .
Ilium length	1.0	. .	1.3[1]	1.3[1]	.	.
Pubis length	2.4				.	. .
Inlet, sagittal diameter	1.1	. .	. .	. .	. .	. .
Ilium breadth	. .	1.7[1]	2.3[1]	1.9[1]	1.7[1]	1.2[1]
Ischium length	. .	. .	. .	. .	. .	. .
Breadth of greater sciatic notch	2.7	1.4	1.9	.	. .	1.1
Pelvic index	. .	1.5	.	.	. .	.
Inlet index	1.7	. .	. .	. .	. .	.
Iliac index	. .	1.8[1]	1.9[1]	1.6[1]	1.5[1]	
Sacral index	. .	. .	. .	.	. .	. .
Relative inlet breadth	2.0	2.1				
Anterior segment index	1.0	2.7				

[1] Boys' mean larger.

In certain other items, the differences between boy and girl infants, while suggestive of a real difference, cannot be judged significant from the present data. Such items are shown in table 13.

Certain items, such as inlet breadth, ischium length and sacral index show no evidence of a significant sex difference at any of the age-levels studied.

[3] The statistical significance of the difference between means was tested by the formula, Critical Ratio $= \frac{\text{Difference between means}}{\sigma \text{ difference}}$, where the

σ difference $= \sqrt{\sigma^2_{M_1} + \sigma^2_{M_2}}$, and $\sigma M = \sqrt{\frac{\sigma}{N}}$ or $\sqrt{\frac{\sigma}{N-1}}$, depending on the size of the sample.

The values of the critical ratio seem to show a slight tendency to become smaller with age, within a particular measurement. However, this observation is somewhat tenuous on the basis of the data at present available. If such a finding were established, on a study carried beyond the age-limits of the present study, it would lend support to Scammon's statement in Abt ('23): "The sexual differences of the newborn pelvis, aside from that of size, are lost during the period of early rapid growth . . ." (p. 278).

The anterior segment index is of particular interest, since it is one of the values mentioned by Morton ('42) as showing a significant sex difference in pre-pubescent children. Morton indicates that Yamamura

TABLE 12

Significant (5% level) sex differences.

ITEM	AGE-LEVEL	SEX LEADING
Pelvis height	3, 6, 9, 12 months	Boys
Bi-ischial breadth	Birth and 1 month	Girls
Pubis length	Birth	Girls
Ilium breadth	Birth and 1 month	Boys
Breadth of sciatic notch	Birth	Girls
Relative inlet breadth	Birth and 1 month	Girls
Anterior segment index	1 month	Girls

TABLE 13

Suggestive (critical ratio 1.9, 1.8) sex differences.

ITEM	AGE-LEVEL	SEX LEADING
Pelvis breadth	1 month	Boys
Inter-pubic breadth	1 month	Girls
Ilium breadth	6 months	Boys
Breadth of sciatic notch	3 months	Girls
Iliac index	1 and 3 months	Boys

('39) also found a sex difference in this characteristic, but examination of the latter's paper did not confirm this observation. This index is a measure of the relative length of that portion of the anteroposterior breadth of the inlet that lies in front of the line of the greatest transverse breadth. Morton reports an index which is larger for girls, that is, shows a relatively shorter anterior segment in the girls than in boys. The present study concurs in this finding; the difference is statistically significant at 1 month.

Another sex difference becomes noticeable upon a further examination of pelvis height and the factors which constitute it. Pelvis height consists, practically speaking, of the ilium length value, the ischium

length value, and a residual value representing the cartilaginous space or gap between the distal ilium and the proximal ischium. This "ischio-iliac space" corresponds to the Y-cartilage interval described by Burman and Clark ('40). Concerning this area, they say: "In the first year of life, the Y-shaped cartilage remains clear, the space between the upper and lower parts of this cartilage being roughly 2–3 mm. There is some narrowing of this space in the later months of the first year of life." (p. 40.)

This ischio-iliac space, then, is approximately equal to the difference between the pelvis height and the sum of the ilium and ischium lengths. If such a value is calculated from the appropriate norms, the derived ischio-iliac value, for the six age-levels, is: Boys (in mm.), 4.1, 3.9, 4.8, 4.8, 3.8, 3.6; girls, 3.1, 2.6, 3.3, 3.0, 1.7, 1.8.

Thus, not only does the ischio-iliac space show a slight tendency to become smaller with age, which is in agreement with Burman and Clark's findings, but also the values for the boys are consistently larger at each age-level than the values for the girls (fig. 5). This possible sex difference was then tested by careful direct measurements of the tracings, at birth and 1 month. A critical ratio of 2.9 (significant) was found at birth, and 1.3 at 1 month.

There is thus a significant sex difference in the ischio-iliac space at birth. This space is undoubtedly the factor making for the major part of the sex difference in pelvis height at the upper age-levels.

The sub-pubic angle has been frequently used as a criterion of sex differences, in fetal life as well as among adults. A real effort was made to obtain a value which would adequately express this angle, but the bony subpubic area is not sufficiently delineated at this age to make a satisfactory measurement possible.

Discussion of sex differences. The sex differences which have been mentioned must be examined further. It has been already stated that, depending upon the type of measurement involved (group A or B), a significant difference between two series might be explained in more than one way. This statement can be amplified by an example. The boys are significantly larger than the girls in pelvic height at 3 months. This may be an actual size difference; but another possible explanation must be examined. If boys showed a substantially different degree of pelvic inclination than girls at this age-level, it is possible that measurements of pelvic height taken on one sex might be considerably different than measurements of pelvic height taken on the other sex, if pelvic inclination affects the height measurement.

By taking roentgenograms on the same pelvis, at different degrees of pelvic tilt, the effect of tilt upon pelvic measurements may be studied. If pelvic tilt does not affect the value of a measurement, then a difference between two groups with respect to this measurement cannot reasonably be ascribed to pelvic tilt, even though the groups may differ in pelvic tilt. Conversely, if an increase in pelvic tilt affects a measurement, and a subsequent examination of two groups shows a difference between the groups in this measurement, it must be assumed that pelvic tilt may be responsible, at least in part, for the difference shown.[4]

TABLE 14

The effect of pelvic tilt on measurements of the pelvis, compared to sex differences (C.R. of 1.0 and more).

ITEM	GROUP	EFFECT OF TILT ON MEASUREMENTS [1]	SEX DIFFERENCES B	1	3	6	9	12
Pelvis height	A	No change	–	–	B	B	B	B
Pelvis breadth	A	No change	B	B	–	–	–	–
Inlet breadth	A	No change	–	–	–	–	–	–
Inter-iliac breadth	A	No change	B	–	–	–	–	–
Inter-pubic breadth	A	No change	G	G	–	B	–	–
Bi-ischial breadth	A	No change	G	G	–	–	–	–
Ilium length	A-B	Slight increase	G	–	B	B	–	–
Pubis length	A-B	Slight decrease	G	–	–	–	–	–
Sagittal inlet, diam.	B	Marked increase	G	–	–	–	–	–
Ilium breadth	B	No change	–	B	B	B	B	B
Ischium length	B	No change	–	–	–	–	–	–
Breadth of sciatic notch	B	Marked increase	G	G	G	–	–	G

[1] Position of infant unchanged; rays tilted 10° toward feet.

Table 14 shows the results of experimental films taken, both on infants and on skeletal material. Films taken from direct anteroposterior position were compared with films taken on the same subjects at 10° of pelvic tilt. In the same table, the sex differences already indicated are shown in the appropriate columns.

An inspection of table 14 indicates that in two instances sex differences in specific measurements must be interpreted with the possibility in mind that these differences may be due at least in part to sex differences in pelvic tilt. These two measurements are the sagittal inlet breadth and the breadth of the sciatic notch. Any sex differences found

[4] The problem of sex differences in pelvic inclination in early infancy must await further evidence. There has been some work done at older age-levels. Kuhns ('35) says that the female "usually has a greater obliquity than the male" (p. 17). However, Reynolds and Hooton ('36) and Young and Ince ('40), in roentgenologic studies on adults, could find no significant sex differences in pelvic inclination. A few studies, such as Kraneburg ('29, not seen), have been made on age-changes in pelvic inclination.

in the other ten measurements may be reasonably attributed to differences in size.

Keeping in mind the above qualifications, the general pattern of sex differentiation in the infant pelvis admits of at least a tentative conclusion. The boys tend to lead in such items as pelvis height and breadth, ilium length and breadth, and the inter-iliac breadth. The girls tend to lead in such items as actual and relative depth of the inlet, relative breadth of the inlet, inter-pubic breadth (at birth and 1 month), bi-ischial breadth, pubis length, and breadth of the sciatic notch. Such selective leadership lends support to the suggestion that boys tend to be larger in measurements which represent the outer structure of the pelvis; while girls tend to be larger in measurements which represent the inner structure of the pelvis, and have a relatively larger inlet.

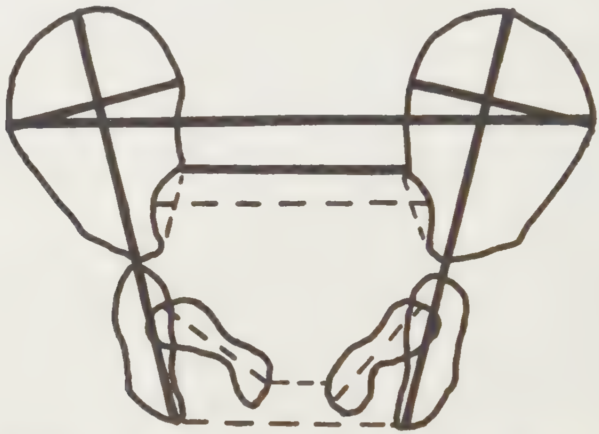

Fig. 6 Sex differences in pelvic measurements. Solid lines: boys tend to be larger; broken lines: girls tend to be larger.

These sex differences are shown diagrammatically in figure 6.

Sex differences in coefficients of variation. A comparison of the sexes on the basis of the coefficients of variation is shown in table 15. The more variable sex is indicated in each case by the appropriate letter (B or G).

The girls show a tendency to be relatively more variable. Out of fifty-two comparisons of the coefficient of variation, the girls show the highest value in thirty-one cases, the boys in twenty-one. The tendency for the girls to be the more variable sex is pronounced at 3, 6, and 9 months.

When individual measurements are examined the boys show greater variability in inter-iliac breadth, ischium length and pubis length; the girls lead in pelvis height, inter-pubic breadth, bi-ischial breadth, ilium length and breadth, and breadth of sciatic notch.

The finding of greater variability in pelvic measurements of girls during early infancy is in agreement with the work of Howells and Hotelling ('36) on adult skeletal material in Indians.

TABLE 15

A comparison of the sexes on the basis of the coefficient of variation.

ITEM	AGE-LEVEL						BOYS	GIRLS	TOTALS
	B	1	3	6	9	12			
Pelvis height	B	B	G	G	G	G	2	4	6
Pelvis breadth	B	G	–	–	–	–	1	1	2
Inlet breadth	G	B	–	–	–	–	1	1	2
Inter-iliac breadth	B	B	–	–	–	–	2	0	2
Inter-pubic breadth	G	B	G	G	G	B	2	4	6
Bi-ischial breadth	G	G	–	–	–	–	0	2	2
Ilium length	B	G	G	G	G	B	2	4	6
Pubis length	G	B	B	B	B	G	4	2	6
Inlet, sagittal diameter	B	G	–	–	–	–	1	1	2
Ilium breadth	G	G	G	G	G	G	0	6	6
Ischium length	G	B	G	B	B	B	4	2	6
Breadth of greater sciatic notch	G	B	G	G	G	B	2	4	6
Number of times boys lead	5	7	1	2	2	4	21		
Number of times girls lead	7	5	6	5	5	3		31	
Totals									52

3. *The relation of pelvis size and shape at birth to infant structure and locomotion*

In this section, an attempt is made to get preliminary impressions of the relationship of pelvis size and shape to other measures of body structure and development, and to the beginning of walking in the infant.

Pelvis breadth was chosen as a good representative of general pelvis size, because of its high correlations with other pelvic measurements, and its proven close association with the anthropometric bi-iliac value. For certain purposes, pelvis height and bi-ischial breadth were also used. Pelvic index was used as a measure of outer pelvis shape, and inlet index as a measure of inner shape.

An examination was made of the relationship of these pelvic items to the following factors: shape and size of the body at birth; shape and size of the infant head at birth; skeletal and tooth development; and

age of walking. The Pearson coefficient of correlation (r) was used. The sexes were treated separately.

Size and shape of the body at birth. Table 16 shows the coefficient of correlation (r) between certain pelvic values and body weight, body length and the weight/length-cubed index at birth.

There is a significant positive relationship, for both sexes, between pelvis breadth and birth weight and length. A large pelvis is associated with a greater birth weight and a greater birth length. A significant positive relationship also exists between pelvis size and the weight/length-cubed index for girls, but not for boys. That is, for the girls, a larger pelvis at birth is associated with a relatively as well as an absolutely heavier child.

TABLE 16

The relation of size and shape of pelvis at birth to size and shape of body at birth.

ITEMS COMPARED	BOYS			GIRLS		
	n	r	Significant?	n	r	Significant?
Pelvis breadth and birth weight	42	+ .75	Yes (1%)	47	+ .58	Yes (1%)
Pelvis breadth and birth length	40	+ .68	Yes (1%)	40	+ .42	Yes (1%)
Pelvis breadth and weight/length ^{3} index	34	+ .18	No	35	+ .43	Yes (1%)
Bi-ischial breadth and birth weight	43	− .03	No	47	+ .34	Yes (5%)
Bi-ischial breadth and birth length	40	− .10	No	40	+ .32	Yes (5%)
Pelvis index and weight/length ^{3} index	34	+ .14	No	35	− .08	No
Inlet index and weight/length ^{3} index	33	+ .09	No	33	− .13	No

Bi-ischial breadth showed significant positive associations with birth weight and length for girls, but not for boys.

No significant relationships between either the pelvic or the inlet index and the body index are observable from the data.

The relationship between pelvis breadth, birth weight and birth length was further examined by means of partial correlation, as shown in table 17.

The zero order coefficients were: pelvis breadth and weight, + .75; pelvis breadth and length, + .68; body weight and length, + .63. It can

thus be seen that pelvis breadth correlates more highly with both of the body values than they do with each other. Moreover, pelvis breadth is more closely associated with body weight than with body length.

Mijsberg ('26) says that pelvis height shows a positive correlation with body length. Since the pelvis height and the pelvis breadth are highly associated (+ .83), this statement is in accordance with the present findings.

TABLE 17

Partial correlations between pelvis breadth, body weight and body length at birth.

ITEMS COMPARED	ITEMS HELD CONSTANT	PARTIAL r
Pelvis breadth and body weight	Body length	+ .56
Pelvis breadth and body length	Body weight	+ .40
Body weight and body length	Pelvis breadth	+ .25

TABLE 18

The relation of size of pelvis to skeletal and tooth development.

ITEMS COMPARED	BOYS			GIRLS		
	n	r	Significant?	n	r	Significant?
Pelvis height (12 months) and skeletal age (Fels, 12 months)	29	+ .50	Yes (1%)	29	+ .19	No
Pelvis breadth (birth) and time of appearance of 1st tooth	39	+ .33	Yes (5%)	43	+ .22	No
$\frac{\text{Birth weight}}{\text{Pelvis breadth}}$ and time of appearance of 1st tooth	38	+ .23	No	43	+ .30	Yes (5%)

Head size and shape. In this section, two correlations were made for each sex. In the first, the inlet index and the cephalic index showed no evidence of a significant association (30 boys, − .18; 30 girls, .00). The second correlation, between inlet breadth and head circumference, shows a definite size factor. The values were: for thirty-one boys, + .51; for thirty girls, + .36. The boys' coefficient is significant at the 1% level, the girls' at the 5% level.

There is a significant positive association, therefore, between size of infant inlet and size of infant head at birth.

Skeletal development and the appearance of the first tooth. Table 18 shows coefficients of correlation between certain pelvic values, and the development of bone and teeth in the infant. A skeletal age for each Fels child is determined on the basis of the time of appearance of certain ossification centers in the joints on the left side of the body (Pyle and Sontag, '43). The time of appearance of the first tooth was obtained from the records of both mothers and observers.

Pelvis height and Fels skeletal age show a significant positive relation at 12 months for boys only. Thus, in boys, a large pelvis is associated with advanced ossification, as here defined. In boys, pelvis breadth at birth shows a significant positive relationship with the time of appearance of the first tooth; in girls, although the coefficient is positive (+ .22), it is not large enough to be considered statistically significant.

When the pelvis breadth is corrected for the weight of the child at birth, by using a birth weight/pelvis breadth index, the association with the time of appearance of the first tooth is still positive for both sexes, with the statistical significance reversed.

TABLE 19

The relation of size of pelvis at birth to age of walking.

ITEMS COMPARED	BOYS			GIRLS		
	n	r	Significant?	n	r	Significant?
Pelvis breadth and age of walking	34	− .03	No	38	+ .27	No
Bi-ischial breadth and age of walking	35	− .26	No	38	.00	No
$\frac{\text{Birth weight}}{\text{Pelvis breadth}}$ and age of walking (observer's records)	31	+ .24	No	38	+ .09	No
$\frac{\text{Birth weight}}{\text{Pelvis breadth}}$ and age of walking (parent's records)	28	+ .17	No	32	+ .08	No

Pelvis size thus tends to be positively associated with advanced skeletal development and early appearance of the first tooth in infants.

Age of walking. An attempt was made to obtain data on age of sitting and standing, in addition to the age of walking, but only the latter information was sufficiently complete to make a statistical treatment worthwhile. Table 19 shows coefficients of correlation between various pelvis values and age of walking.

As seen in the table, data from observer's records and from mother's reports showed no appreciable difference, when correlated with the relative pelvic breadth.

No significant associations between age of walking and pelvis breadth, bi-ischial breadth, or birth weight/pelvis breadth index were found. It may be said, therefore, that so far as the present data can determine, no significant relationship exists between pelvis size and age of walking.

4. *Hereditary aspects of pelvis size and shape at birth*

Possible hereditary factors in the size and shape of the pelvis at birth have been examined in two ways. First a comparison has been

made of certain pelvic values in the newborn child with corresponding values for the mother, using the coefficient of correlation (r). The inlet is the area in which such comparisons are possible, using the available data. Boys and girls are treated separately.

The second approach is by a comparison of siblings with an equally large series of non-siblings. In this instance, a determination was made whether differences between siblings, with respect to various pelvic dimensions, were significantly smaller than differences between unrelated children.

The relation of size and shape of the infant inlet to the inlet of the mother. On all Fels mothers, in the late months of pregnancy, a standard Thoms ('33, '38) roentgenogram of the pelvic inlet is taken. The

TABLE 20

The relation of size and shape of the infant inlet to size and shape of the inlet in the mother.

ITEMS COMPARED	BOYS			GIRLS		
	n	r	Significant?	n	r	Significant?
Sagittal inlet, mother and newborn child	23	+ .23	No	23	+ .04	No
Inlet breadth, mother and newborn child	24	+ .52	Yes (1%)	23	+ .39	Yes (5%)
Inlet index, mother and newborn child	23	+ .31	No	23	+ .19	No

absolute diameters of the mother's inlet can be obtained from such a film, and the inlet index (Turner, 1886) calculated. These data were correlated with certain infant pelvic items, as shown in table 20.

No significant relationship was found between the anteroposterior diameter of the mother's inlet, as read from her Thoms film, and the sagittal inlet value for her child. Nor was a significant relationship found between the inlet indices of the two groups, in either sex.

However, a significant association was found between the inlet breadth of the mother and child, for both sexes. Mothers with wide inlets tended to have infants with wide inlets. The relationship is probably a part of a whole complex of size relationships between mother and infant. For instance, mother's weight and infant's birth weight show a low positive correlation (Sanders,'34, p. 70).

A comparison of siblings and non-siblings with respect to size and shape of pelvis. Thirty-one pairs of siblings were available for the present section of the study. The average difference between paired siblings, for various pelvic measurements, was obtained. Similar values

for an equally large group of paired non-siblings, with comparable sex ratios, was obtained. The non-siblings were paired at random.

The means obtained from the two groups were tested for the statistical significance of their differences. The results are shown in table 21.

There are no statistically significant differences between siblings and non-siblings, using a critical ratio of 2.0 as a criterion. However, in both pelvis breadth and pelvis height, with critical ratios of 1.9 and 1.8, respectively, suggestive differences are found. In all cases, the siblings show smaller differences between their paired items than do the non-siblings.

TABLE 21

Significance of differences between siblings and unrelated children with respect to size and shape of pelvis at birth.

ITEM	MEAN DIFFERENCE BETWEEN SIBLINGS	MEAN DIFFERENCE BETWEEN NON-SIBLINGS	DIFFERENCE BETWEEN MEAN DIFFERENCES	C.R.
Pelvis breadth	4.67	6.50	1.83	1.9
Pelvis height	2.48	3.64	1.16	1.8
Inlet breadth	1.82	2.38	.56	1.0
Pelvic index	3.09	3.66	.57	1.0
Inlet index	6.50	8.03	1.53	1.2
Sacral index	2.98	3.36	.38	.6
$\frac{\text{Birth weight}}{\text{Pelvis breadth}}$	4.06	5.28	1.22	1.1

On the basis of the present data, therefore, it cannot be said that a hereditary factor, as evidenced by differences between siblings and non-siblings, has been established. Nevertheless, the values for pelvis breadth and pelvis height are interesting, and merit further investigation.

SUMMARY AND CONCLUSIONS

In a roentgenometric study of the human bony pelvis from birth through 12 months, the following problems were investigated: (1) Growth patterns of the pelvic girdle during the first year of life. (2) The possibility of the existence of demonstrable sex differences. (3) The relation of pelvic structure, at this age, to body size and shape, to skeletal and tooth development, and to the age of walking. (4) Hereditary aspects of the size and shape of the pelvic girdle at birth.

The data were derived from measurements and indices taken on tracings of 467 serial roentgenograms of ninety-five infants. The infants are regular subjects of the Samuel S. Fels Research Institute. Roentgenograms were taken at birth and at 1, 3, 6, 9 and 12 months of age.

Standard statistical procedures were used to bring out salient information concerning the four problems mentioned above. Means, standard deviations, and coefficients of variation are given for all items. All basic measurements were intercorrelated at birth, and certain birth values were correlated with their corresponding values at 12 months. Growth curves for the first year were constructed. All calculations were checked.

The principal conclusions of the present study are summarized, by section.

1. Growth changes

1. A fairly high correlation pattern exists between measurements taken at birth. Forty-four out of sixty-six paired items show a highly significant correlation coefficient. Nine of the twelve basic measurements are significantly intercorrelated. Two syndromes (r of + .50 and higher) can be derived: one relates to general pelvic conformation, the other to anteroposterior dimensions.
2. Possible causes of differentials in intercorrelation pattern are discussed.
3. During the first year of life, the pelvis as a whole grows fastest from birth to 3 months, and the rate of growth steadily declines from 3 months to 1 year. Such a pattern may be seen in pelvis height, ischium length, pubic length, and ilium length and breadth.
4. Indices and certain measurements show patterns of growth related to their particular properties.
5. The growth curves for boys and girls tend to run a parallel, but not always an identical course.
6. The coefficient of variation is generally highest at birth. This may be due to greater variability in positioning at birth.
7. Significant correlations between birth values and values at 1 year are found for pelvis height, ilium length, ischium length and pubis length.

2. Sex differences

1. Boys show higher intercorrelations in measurements at birth than girls.
2. Significant sex differences in measurements and indices are found as follows: Boys lead in pelvis height, ilium breadth and ischio-iliac space. Girls lead in bi-ischial breadth, pubis length, breadth of greater sciatic notch, relative inlet breadth, and anterior segment index.

3. Suggestive, but not statistically significant sex differences are found in pelvis breadth and iliac index (boys lead), and in inter-pubic breadth (girls lead).

4. Critical ratios of sex differences show a slight tendency to become smaller with age.

5. The possibility that pelvic tilt may be a causative factor in certain sex differences is discussed.

6. Measurements of girls tend to be more variable than measurements of boys.

7. The general pattern of sex differences in the pelvis, as shown by the present study, seems to favor the hypothesis that boys are larger in measurements relating to the outer structures of the pelvis, while girls are larger in measurements relating to the inner structures of the pelvis, including a relatively larger inlet.

3. Structural and functional relations

1. There is a significant positive relationship, for both sexes, between the size of the pelvis at birth, and birth weight and length. A larger pelvis is associated with a heavier and longer infant at birth.

2. In girls only, there is a significant positive relationship between the size of the pelvis and the weight/length index of the body at birth. A larger pelvis at birth is associated in girls with a relatively heavier body build.

3. In girls only, there is a significant positive relationship between bi-ischial breadth, and birth weight and length. A larger bi-ischial breadth at birth is associated in girls with a heavier and longer infant.

4. No significant relationship was found between the shape of the pelvis or of the inlet and the body build index.

5. Pelvis size is more closely related to body weight than to body length at birth, and more closely related to either of these items than they are to each other.

6. No significant relationship was found between the shape of the inlet of the infant and the shape of the head of the infant at birth.

7. There is a significant positive relationship, for both sexes, between the size of the pelvis and the size of the head of the infant at birth. Larger pelves in infants are associated with larger heads at birth.

8. In boys only, a significant positive relationship is found between size of the pelvis at 12 months and advanced ossification. Larger pelves are associated with earlier appearance of ossification centers in boys.

9. In both sexes, a significant positive relationship is found between size of the pelvis at birth and time of appearance of the first tooth. Larger pelves are associated with earlier appearance of the first tooth.

10. No significant relationship could be found between pelvis size or shape and time of walking.

4. *Hereditary aspects*

1. A significant positive relationship is found between inlet breadth in the newborn infant, and inlet breadth in the mother of that infant, for both sexes. A wider inlet in the infant is associated with a wider inlet in the mother. In this characteristic, male infants showed a closer association with their mothers than did the female infants.

2. No significant relationship could be found between the sagittal inlet or the inlet index of the newborn infant, and the sagittal inlet or the inlet index of the mother of that infant.

3. Suggestive, but not statistically significant, differences are found between siblings and non-siblings in the similarity of paired infants in pelvis breadth and height at birth. Further investigation of this problem is suggested. In all cases, siblings are closer to each other in the means of various measurements taken at birth than are non-siblings.

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REVIEW

THE ANTHROPOLOGY OF KODIAK ISLAND. By ALEŠ HRDLIČKA. The Wistar Institute of Anatomy and Biology, Philadelphia. xix + 486 pp., 228 text figures, bibliography, index, 1944. ($5.00).

THE ALEUTIAN AND COMMANDER ISLANDS AND THEIR INHABITANTS. By ALEŠ HRDLIČKA. The Wistar Institute of Anatomy and Biology, Philadelphia. xx + 630 pp., 239 text figures, bibliography, index, 1945. ($5.00)

Dr. Hrdlička's last seven seasons of field work, between 1931 and 1938, were spent on Kodiak and the Aleutian Islands. On Kodiak his were pioneer efforts; in the Aleutians he followed Dall and Jochelson, but in both places his excavations yielded materials that are basic to our understanding of the anthropology of northwestern America. These two handsome volumes, the manuscripts of which were completed only 6 months before his death on September 5, 1943, are a fitting monument to a long and productive career.

The primary purpose of Dr. Hrdlička's investigations — the collection of skeletal material — led to extensive excavations of old village sites and burial caves. Between 600 and 700 skulls, many skeletons, and vast quantities of archeological material were brought back to the U. S. National Museum.

The two volumes have essentially the same arrangement, the greater part consisting of a voluminous and thorough survey of the literature and a day by day narrative account of the travels and work of each season's expedition. There are shorter sections devoted to geography, descriptions of artifacts and skeletal material, and yearly summaries of results accomplished. Physical anthropology, the subject of this review, is allotted 80 and 97 pages, respectively, in the Kodiak and Aleutian volumes. Measurements of individual crania are not given, having been published already in the author's Catalog of Human Crania: Non-Eskimo People of the Northwest Coast, Alaska, and Siberia ('44).

The outstanding result of the excavations was the discovery that the original inhabitants of Kodiak and the Aleutian Islands differed physically, and also culturally, from those found by the Russians. On Kodiak the earlier people, or "Pre-Koniag", represented by skeletons from the lower levels of the midden, possessed a relatively more advanced material culture, and were oblong-headed. Three or four hundred years ago this early population was replaced — annihilated or driven out — by the modern "Koniag", a broad-headed people somewhat resembling the Aleuts. In the Aleutians, the original inhabitants the "Pre-Aleut", were dolicho- to mesocephalic and rather low-vaulted, in contrast to the broad-headed, very low-vaulted Aleuts who moved into the Islands a few centuries ago. These findings have important implications for American anthropology and as they form the basis of Dr. Hrdlička's final pronouncements it seems justified to examine them in some detail.

Most of the Koniag and Pre-Koniag crania came from a large site in Uyak Bay, on the north side of Kodiak Island, where Dr. Hrdlička and his assistants excavated intensively for about 10 months between 1931 and 1936. The site had

been abandoned at the time of, or shortly after, the arrival of the Russians in the 18th century. The eighty-nine Koniag crania, from the upper parts of the 12-foot high midden, are short, broad, and moderately high; the face is very broad and somewhat low, the orbits fairly high and broad and the nose somewhat low and broad. As Dr. Hrdlička emphasizes, it is a type that shows hardly any resemblance to that of the Eskimo, and comparisons of the long bones of the two groups and measurements on eleven living Koniag males point to the same conclusion. However, this hardly justifies the criticism that the Kodiak people in the past have been mistakenly identified as Eskimo. Whatever their physical type, they actually are Eskimos, both in speech and culture. In this respect they are like some other Eskimo groups whose physical types have been altered through Indian contact.

The problem is to account for the sudden and late appearance of such an extreme broad-headed population on Kodiak Island, for if Dr. Hrdlička is correct it was not brought about by infiltration or modification but by complete replacement of the original Pre-Koniag stock. First it may be noted that the Prince William Sound Eskimos, the Chugachmiut (Oetteking, this Journal N.S., vol. 3, nos. 1–3, '45), adhere to the general Eskimo norm physically, and are even more different from the Koniag than are the Bering Sea Eskimos. It is interesting that the Chugachmiut, an Eskimo enclave surrounded by Athabaskan, Eyak, and Tlingit Indians, have remained essentially Eskimo in physical type, in strong contrast to their linguistic kinsmen the Koniag. An explanation of the Koniag cranial type might be possible if we had adequate skeletal material from Cook Inlet and the Alaska Peninsula. At present, however, as the author shows, the people most closely resembling the Koniag are the modern Aleuts. The facial measurements are almost identical, though the Aleut skull is longer and lower and there are recognizable differences in some of the long bones.

Beneath the Koniag deposits, which formed the upper one-third of the huge Uyak Bay midden, were those of the original settlers of Kodiak Island, the Pre-Koniag, who are thought to have occupied the site for some 12 to 15 centuries. Compared with the Koniags, the Pre-Koniag crania (65 male, 110 female) are longer, narrower, and higher, and the face likewise narrower and higher. "Though both groups belonged to the Yellow-brown human stem, there would be no possibility of even distantly connectinig the two skull types — they belong to substantially different anthropological strains, as far apart at least as the Nordics and Alpines among the White people." ('44, p. 411.)

The Pre-Koniag crania are next compared with a pooled Eskimo series (995 male, 1068 female) representing groups from S. W. Alaska to Greenland. Though a proportion of the Pre-Koniag skulls have an Eskimo "physiognomy," metrical comparison with the Eskimo series reveals numerous differences which lead to the following conclusion:

> "The amount of the differences and the important nature of those of the vault and face, definitely dissociate the Pre-Koniag from the Eskimo skull and indicate that the two were different peoples. The occasional Eskimoid features in the face mean therefore, in all probability, only basic racial similarities and not direct group connections; though there may well have been also some old Eskimo admixture." ('44, p. 411.)

On the other hand, Dr. Hrdlička detects striking resemblances between the Pre-Koniag and a pooled series of 250 Algonquian skulls from the eastern United

States. In the dimensions of the vault and nose, and also in facial breadth the two types are very similar. The Algonquian face and orbits are much lower than the Pre-Koniag, "but these differences might have been due to functional causes, which would not apply to the vault, and are of less importance. Thus in its brain case, and in the dimensions of the nose, the Pre-Koniag skull may legitimately be classed as of the Algonquin type." ('44, p. 413.)

In support of the Algonquian relationship, the author points to a small group of Algonquian-like Indian crania (5 male, 13 female) from Shageluk Slough, off the lower middle Yukon, which closely resemble the Pre-Koniag. Measurements of the Pre-Koniag, Shageluk, and Algonquian are compared in a table and interpreted as follows:

> "The close relation of the three groups is obvious, the only material differences being in the lower cranial index of the Shageluks, which however is within the range of variation of the index within the different Algonquin groups . . . We have thus in the Far Northwest two people, one extinct and one still living, who belong evidently to that large mass of American aborigines who are encompassed under the term Algonquin, and secondarily under the Shoshonean, Piman, and Aztecan denominations. These people differ somewhat among themselves, but they have so much in common that they may legitimately be regarded as one great American family . . .
>
> An intriguing suggestion that forces itself on the observer of these two Alaskan groups is that they may possibly be but one, and that the Shageluks may be the survivors of the Pre-Koniag people from Kodiak Island. The distance between the two, less than 400 miles, is not great for Alaska, and the Shageluks seem clearly an intrusion into the Yukon region. That they are therefore derived from the old Pre-Koniags is not impossible; but it would be difficult and probably hopeless at this date to establish positive proof of the connection; and the lower cranial index of the Shageluks, as well as their higher stature, suggests that probably they are a separate group or strain of the same people. ('44, p. 415)
>
> The final justified conclusion is that the Pre-Koniags were an early strain from Asia, physically related slightly to the Eskimo, but much more so to the Algonquin . . . ('44, p. 434)

Dr. Hrdlička's conclusion that the people preceding the Kodiak Eskimo were more Indian than Eskimo in physical type would seem to afford support to the theories of Boas, Birket-Smith, and Shapiro that the Alaskan Eskimos as a whole were either preceded or in later times altered culturally and physically by Indian groups from the interior or the Northwest Coast. Jenness, de Laguna, and the present reviewer have felt that the archeological evidence is opposed to such a theory.

The reader who wishes to form his own conclusion as to the bearing of the Kodiak evidence on this problem must turn again to the question of the alleged dissimilarity between the Pre-Koniag and Eskimo crania. This dissimilarity, I believe, has been given undue emphasis because of the manner in which the Eskimo series were grouped. The means of the Pre-Koniag crania are compared not with those of any particular group but with the range of means of large aggregates of Eskimos as given in the general abstract of the author's Catalog of Human Crania: Eskimos in General ('42, pp. 406–8). There all of the Bering Sea crania from Bristol Bay to Norton Bay are combined into two groups, "Great Western Rivers with Intermediate Coasts" (124 males, 117 females) and "Northeastern Bering Sea" (76 males, 73 females). Comparing the Pre-Koniag means with the minimum to maximum range of means of such large

groupings of Eskimos from Bering Sea to Greenland results in many of the Pre-Koniag measurements and indices falling outside the Eskimo range. However, if the Pre-Koniag are compared separately with the various local Eskimo groups nearest to Kodiak Island a different result appears. In a comparison of this kind the Pre-Koniag cranial length and height, cranial index and mean height index no longer fall outside the Eskimo range. In other features too these Eskimo groups north of Kodiak show resemblances to the Pre-Koniag closer resemblances than do the Algonquian.

In the following table I show the means of ten measurements and six indices of the male Pre-Koniag together with the differences between these and the means of other groups given in the Catalog. In average differences the Koniag, Aleut and Pre-Aleut are all substantially removed from the Pre-Koniag. The Algonquians are somewhat closer, but not as close as any of the Bering Sea Eskimos. Beyond the Bering Sea we find the long and narrow-headed, narrow-nosed Eskimo, the classic Eskimo type that in one form or other extends from Seward Peninsula east to Greenland, and this type shows little resemblance to the Pre-Koniag. The latter, however, cannot be dissociated from the Bering Sea Eskimos with whom on the whole they show close agreement.

As for the Shageluk, a similar explanation seems possible, one that is simpler and more inherently probable than the postulated unique relationship to Pre-Koniag and Algonquian. Comparison of the means of measurements and indices of male Shageluks with those of Algonquian and Eskimo groups of Seward Peninsula and Arctic Alaska shows significantly closer resemblances to the latter. This is not surprising in view of the Shageluks' location near the Eskimo-Indian boundary on the Yukon. Average differences between Shageluk and Algonquian, calculated in the same manner as in the table, are 2.60 for measurements and 3.55 for indices; between Shageluk and Golovin Bay, 1.37 for measurements and 1.60 for indices; Shageluk and Port Clarence, 1.83 and 1.78; Cape Prince of Wales, 1.37 and 1.55; Metlatavik (north of Wales), 1.77 and 1.70; Shishmareff, 1.71 and 2.53; Pt. Hope, 1.53 and 1.72; Pt. Barrow, 1.71 and 1.66. In short the Shageluks appear to be an Indian group whose physical type is close to that of the north Alaskan Eskimo.

Following the Kodiak work Dr. Hrdlička turned to the Aleutians, where during the summers of 1936 to 1938 he and his volunteer assistants excavated and explored from one end of the chain to the other. The major excavations were made on Amaknak (Dutch Harbor) and Umnak in the Fox Island group, Amchitka and Kiska in the Rat Islands and on Agattu, one of the westernmost islands. Limited excavations were made on Attu, Kanaga, and Adak, and mummies were collected from burial caves on Shiprock (Umnak Pass), Kagamil and other islands.

In the Aleutian middens, unlike Kodiak, there was no apparent separation of the upper and lower culture levels. However, on the basis of the skeletal remains two distinct periods of occupation were recognized, the upper "Aleut" and the lower "Pre-Aleut."

The long bones showed the Pre-Aleut to have been taller and heavier than the Aleuts. Their skulls were much longer and narrower and their faces somewhat higher than those of the Aleuts. Though their skulls average 2.4 mm. higher than those of the Aleut, they were still among the most low-vaulted crania on the

	PRE-KONIAG	KONIAG	PRE-ALEUT	ALEUT	ALGONQUIAN	NUSHAGAK	KUSKOKWIM	LOWER YUKON	TOGIAK, MUMTRAK, HOOPER BAY	NUNWAK AND NELSON SI. NOR. TO NORTON BAY	GAMBELL, ST. LAWRENCE ISLAND	SHAGELUK. YUKON
	(65)	(50)	(57)	(113)	(250)	(19)	(30)	(41)	(24)	(76)	(153)	(5)
Cranial length	180.0	— 4.5	+ 6.9	+ 0.6	+ 2.0	+ 1.6	+ 2.8	+ 2.7	+ 0.7	+ 7.6	+ 4.0	+ 5.0
Cranial breadth	140.0	+ 10.8	+ 2.6	+ 10.8	— 1.0	+ 3.4	+ 0.4	+ 0.4	+ 2.3	+ 1.1	+ 1.9	— 4.0
Cranial height	139.0	— 3.7	— 7.6	— 10.6	0.0	— 3.5	— 3.2	— 1.8	— 4.2	— 1.7	— 2.2	0.0
Menton-nasion	131.0	— 6.3	— 1.7	— 6.7	— 10.0	— 2.8	— 1.0	— 6.4	— 5.2	— 1.2	— 4.0	— 2.0
Alveolar point-nasion	78.0	— 2.7	— 1.6	— 3.7	— 5.0	— 0.7	— 0.2	— 0.8	— 0.5	+ 1.0	+ 0.2	0.0
Face breadth	140.0	+ 5.6	+ 4.1	+ 4.2	— 1.0	0.0	+ 0.7	+ 0.9	+ 1.3	+ 2.8	+ 2.0	— 3.0
Orbit height, mean	36.5	— 0.7	— 0.3	— 1.0	— 2.5	— 0.3	— 1.0	+ 0.2	— 0.2	0.0	+ 0.2	— 0.5
Orbit breadth, mean	40.0	0.0	+ 0.2	— 0.1	— 1.0	— 1.5	0.0	0.0	— 0.3	+ 0.5	+ 0.3	0.0
Nose height	54.0	— 1.3	— 1.2	— 2.4	— 1.0	— 0.1	+ 0.1	+ 0.2	+ 0.6	0.0	+ 0.2	0.0
Nose breadth	25.0	0.0	+ 0.6	+ 0.4	+ 1.0	— 0.9	— 0.7	— 1.0	— 0.8	— 1.6	— 0.5	0.0
Average difference of measurements		3.56	2.68	4.05	2.45	1.48	1.01	1.44	1.61	1.75	1.55	1.45
Cranial index	77.6	+ 8.3	— 1.3	+ 5.9	— 1.2	+ 1.3	+ 0.2	— 0.7	+ 1.2	— 1.4	— 0.5	— 3.9
Mean height index	87.0	— 4.0	— 7.2	— 9.5	— 0.3	— 3.6	— 3.0	— 2.1	— 3.5	— 3.5	— 3.0	— 0.5
Facial index, total	93.4	— 7.6	— 4.2	— 6.9	— 7.4	— 3.8	— 0.5	— 4.7	— 3.6	— 2.5	— 5.1	+ 0.9
Facial index, upper	56.0	— 4.3	— 3.1	— 4.4	— 3.2	— 0.9	— 0.5	— 1.1	— 1.0	— 0.7	— 0.9	+ 1.1
Orbital index, mean	90.4	— 1.1	— 0.3	— 1.3	— 2.8	— 1.9	— 1.6	+ 0.8	+ 0.9	— 0.3	+ 0.9	— 1.0
Nasal index	46.4	+ 1.0	+ 2.2	+ 2.8	+ 2.7	— 1.6	— 1.5	— 0.2	— 2.1	— 3.1	— 1.2	— 0.3
Average difference of indices		4.38	3.05	5.15	2.93	2.18	1.22	1.60	2.05	1.92	1.93	1.28

continent (131.4 mm.). A Pre-Aleut and Eskimo comparison, on the basis c 60 male skulls from the Kuskokwim, shows numerous similarities but als differences, the Pre-Aleut skull being lower and the face and nose broader tha in the Eskimo. These differences, reinforced by some marked dissimilarities i the long bones, separate the two groups and show that the Pre-Aleuts "wer definitely not Eskimos, nor even their very close relations; though the Eskim may well have differentiated from the same far-back parental stock that gav also the less modified Pre-Aleut people." ('45, p. 579)

A very close similarity is then pointed out between the Pre-Aleut and Siou skulls, from which "the anthropologist would seem justified in assuming tha the two groups had a common and not very far back ancestry." The long bone of the two groups, however, are considerably different, for which reason thi interpretation is presented provisionally.

The remarkably close metrical resemblance between Pre-Aleut and Siou crania should not be allowed to obscure or prejudice our attempt to understan the relationship of Pre-Aleut and Eskimo. Differences between the means c measurements and indices of the male Pre-Aleuts and other groups, calculate as in the Pre-Koniag table, are as follows: Average difference between Pre-Aleu and Sioux, 1.28 for measurements and .88 for indices; between Pre-Aleut an Aleut, 2.43 and 2.02; Pre-Aleut and Kuskokwim Eskimo, 1.89 and 2.62; Nuniva Id. and other Eskimos north to Norton Bay, 1.65 and 2.37; Prince Willian Soun Eskimo, 1.99 and 2.45. To the reviewer, these resemblances between the pr historic Aleutian Islanders and neighboring Eskimo groups, though not clos are as important as the very close but inexplicable resemblance to the Siou Though the author minimizes Eskimo relationship, the fact remains that th Pre-Aleuts with their longer, narrower, and somewhat higher heads and high faces were actually closer to the Eskimo than were the later Aleuts, who them selves spoke a divergent Eskimoid language and possessed a basically Eskim culture. This picture, it may be noted, is in harmony with the recent finding and interpretations of archeology.

Dr. Hrdlička has also pointed out a close resemblance between the moder Aleuts and one small group of Tungus; "If such resemblances have any value — and they surely must have — then the evidence amounts to no less than a demon stration of a close parentage of the two groups. . . ." However because of th smallness of the Tungus series this relationship is presented only as a stron probability. This has important implications but the explanation is difficul As the author shows, the Aleuts must have entered the islands by way of th Alaska Peninsula. This seems inevitable in view of their rather close relation ship to the Koniag and their divergent Eskimo language and culture, and als because of the paucity of Aleut physical remains in the more westerly islanc and the absence of any trace of a Tungusic or other Asiatic language anywher in the archipelago. The difficulty arises in bringing a virtually unmodifie Tungus physical strain to the Alaska Peninsula via Bering Strait, where, as ye there is no suggestion of the type either archeologically or among existing Eskim groups.

The question of an earlier movement of Asiatics over the Aleutian chain left in abeyance. One of Dr. Hrdlička's primary objectives was to investiga the possibility that the Commander Islands had served as stepping stones fro

Kamchatka to the Aleutians. Two visits of 3 and 5 days each confirmed previous evidence that the Commanders were uninhabited in pre-Russian times. This somewhat "puzzling" situation led to the conclusion, written at the time, that both the Pre-Aleuts and Aleuts might have entered the islands from Alaska, but that "it would also have been possible for either the Pre-Aleuts or the Aleuts, or both, to have reached our Islands from the Kuriles, or from the Asiatic mainland north of Kamchatka, missing the Commanders in the fog, or by passing too far north or south of them." ('45, pp. 394–397). In the later conclusions and discussion of the physical evidence no mention is made of the latter possibility.

My explanation of this perhaps over-long review is that Dr. Hrdlička's Kodiak and Aleutian data are of primary importance to Alaskan anthropology and hence subject to discussion and counter interpretation. I do not agree with some of his basic determinations; others no doubt will disagree with mine. All must to some extent remain provisional until the rich archeological materials are studied and also because these volumes contain no detailed depth records that would allow the reader to form independent judgment on the author's conclusions regarding type succession and relationships of skeletal material in the middens.

Prior to Dr. Hrdlička's investigations there was no knowledge whatever of Kodiak anthropology and our information on Aleutian archeology came mostly from Jochelson's relatively limited excavations. The early explorers' descriptions of the Aleuts and Koniags and their culture were contained in Russian and other out-of-print publications difficult to obtain. Dr. Hrdlička has changed this, and it seems fitting that his life-long study of the American aborigines should thus culminate in a work that makes available to the anthropologist and the general reader a mass of new and valuable information on one of the least known sections of North America.

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NOTES

BIBLIOGRAPHY IN PHYSICAL ANTHROPOLOGY

When the New Series of this Journal was started in 1943 the Editor was faced with the problem of how to treat the current literature. In response to general demand he instituted critical reviews in place of the previous brief abstracts. This change left the bulk of the literature in the field unnoticed. This situation, combined with the wartime scarcity of manuscripts, led to the idea of running a classified *Annual bibliography in physical anthropology* in the last number of the year. At the Editor's request, Dr. Krogman, who had only recently published his valuable *Bibliography of human morphology,* consented to organize and edit the annual bibliography.

The first issue had to be assembled rather hurriedly, but it showed the extent of our literary interest. Then Dr. Krogman's duties made it impossible for him to take charge of the second issue. Thereupon Dr. Cobb took over the task and continued the bibliography in its original form, except for the addition of a useful index. Now Dr. Krogman has completed the third issue. In this time-consuming and exacting work neither of these men has received satisfactory cooperation from members of the Association. Indeed, they have encountered disinterest from most members and even opposition from some. In view of the usefulness of bibliographies of this type, and the absence of anything similar in the field of physical anthropology, this reaction has seemed unaccountable.

At the last meeting of the Association there was unanimous agreement to support the proposed new Section H of Biological Abstracts to be devoted to human biology. President Krogman recently has added his personal appeal for this support in a letter to the membership. In view of this evidence that the Association does not wish its Journal to carry an annual listing of the literature in its field, the project will not be continued beyond the present year.

Section H, to be known as *Abstracts of human biology,* will begin in January 1946. The abstracts will be selected and assembled from the regular edition by Dr. Flynn, Editor-in-Chief, with the aid of the Section Editors in the fields concerned. The subjects covered will include biological studies on alcoholism, narcotics, sedatives and drug addiction, crime and delinquency, mental deficiency, nervous and mental disorders, human heredity, biometrical and statistical studies on man, child development, adolescence, growth, nutritional disorders, the biology of the aged person, endocrine bases of personality and behavior, reproduction and sex, population problems and human ecology, race, public health factors affecting population and human adaptation, and similar topics. It is expected that all papers on human and social biology appearing in the 2000 or more periodicals abstracted in Biological Abstracts will be included in Section H.

Section H will be published monthly except during the 4 summer months when it will be published bi-monthly. A volume, coinciding with the calendar year, will consist of ten regular abstract issues plus the comprehensive index issue of the complete edition of Biological Abstracts. A large number of individual subscribers is needed to place this new sectional edition on a self-sustaining basis.

The price is $6.00 a year (Foreign, $6.50). Subscriptions and correspondenc should be addressed to Biological Abstracts, University of Pennsylvania, Phila delphia, 4, Pennsylvania.

A SOCIETY OF PROFESSIONAL ANTHROPOLOGISTS

During the month of October a 10-page mimeographed circular entitle *Proposal for an organization of professional anthropologists* was sent from Wash ington to about 480 anthropologists located throughout the country. This circula which resulted from numerous discussions among a group of 25 anthropologists was sent out by a Temporary Organizing Committee consisting of Julian I Steward, John Provinse, Clyde Kluckhohn, Frank H. H. Roberts, Jr., and Home Barnett (Secretary). An effort was made to include among the recipients of th circular all those who might be eligible for membership.

The need for organizing the professional anthropologists is explained in th proposal as follows:

> "Professional anthropologists belong to one or more of the existent associations or societi but very few indeed belong to all or even to a majority of them. This means that:
>
> 1. The common ground which all professional anthropologists. regardless of their specialt should feel in general anthropology is rapidly ceasing to exercise a desirable unifying for in the total profession.
>
> 2. There is no organization which can speak publicly as truly representative of the who profession.
>
> 3. There is no organization that protects and furthers the interests of anthropology general.
>
> 4. There is no organization that can set standards for the total profession, placing a stan of approval on those who have professional qualifications while withholding it from those wh have not."

The proposal for remedying this situation stresses the viewpoint that a ne society has advantages over such alternatives as reorganizing the America Anthropological Association or federating existing anthropological societie Although this is the opinion of the majority of those who developed the proposa the format of the proposal should be regarded mainly as something concre upon which to base wider discussions.

Some idea of the nature of the proposed new society may be gained from th following quotations from the provisional constitution.

> "Persons shall be eligible for membership who (a) possess a doctorate in anthropology, (b) possess either a bachelor's or master's degree in anthropology or a doctorate in an alli field and at the time of application for membership are employed as anthropologists, or (have made significant published contributions in the field of anthropology. In addition, a applicant must belong to at least one of the accredited national anthropological societi [American Anthropological Association, Society for American Archeology, Society of Appli Anthropology, American Association of Physical Anthropologists, American Folklore Societ Linguistic Society of America] . . . The qualifications of an applicant shall be examin and recommended by the Membership Committee, and, upon being approved by a two-thir vote of the Executive Board, the applicant shall become a member of the Society. Applican

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[1] Including the following members of the American Association of Physical Anthropologist Gordon Bowles, Clyde Kluckhohn, T. D. Stewart.

rejected by the Executive Board may appeal to the general membership of the Society by addressing a communication to the annual meeting . . .

The administration of the Society shall be entrusted to an Executive Board, which shall consist of five members elected at large [or on a regional basis] by the entire membership. In addition, each member may vote for one representative of the subject designated [by him as his field or interest for voting purposes]. These subjects may be as follows: ethnology, social anthropology, archeology, physical anthropology, applied anthropology, folklore, and linguistics . . .

Each of the . . . national anthropological societies shall be invited to designate one member of the Professional Society as its liaison officer . . .''

It is anticipated that such an organization would serve the following purposes:

''1. To agree on the essential core of anthropology (tentatively defined as the 'comparative study of human biology, culture and language') and thus to: a) Counteract the present centrifugal trend in anthropology; b) recommend minimum curriculum standards for different levels of anthropological training; and c) recommend employment standards, e.g., for teachers of anthropology, Civil Service position, etc.

2. To provide a common ground for professional effort by: a) Encouraging the anthropological societies to have joint annual meetings, to include sessions in which the focus of papers and discussion would be upon general anthropology, thus unifying and correlating work in the various fields which at present are drifting apart, owing to the infrequent and haphazard circumstances under which practitioners of the various specialities meet; b) disseminating strictly professional news within the professional group; and c) assisting (if requested by one or more of the societies responsible for anthropological publications) in lowering the costs and raising the efficiency of publishing and distribution by providing a central clearing house for mailing, billing and possibly doing the mechanical side of editorial work.

3. To provide a more effective means of mobilizing professional effort in meeting national and international needs through: a) Development of a public relations program for anthropology; b) creation of committees to act as emergencies arise without first having to solicit funds; c) a survey of the services of anthropologists to the war and of the impact of the war on anthropological thought, teaching, and jobs; d) a survey of anthropological curriculums; e) a survey of anthropological positions and of the qualifications required for them; f) keeping records of anthropological personnel; g) integrating the work of the many existing committees in the anthropological societies and councils that are concerned with professional problems; h) cooperating with the other social sciences in efforts to further national social science effort; i) furthering international relations in anthropology through governmental and non-governmental channels; j) examination of the relationship of anthropology to the research councils; k) publication of a bulletin dealing with professional matters (but no publication of scientific material); and l) stimulation of anthropological research on both a pre- and post-PhD level (but not by receiving and administering research funds).''

The Temporary Organizing Committee requests that anyone eligible for membership write to its Secretary (Smithsonian Institution, Washington 25, D. C.) stating:

1. Whether he believes that a professional organization is desirable.
2. Whether he would become a member of it.
3. What dues he would pay.
4. Whether he favors this kind of: a) Independent organization, b) representation, c) executive board, and d) criteria of membership.
5. Whether he prefers some other way of creating the society.

In order that this proposal receive the attention it merits from the American Association of Physical Anthropologists the following committee has been set up

by President Krogman: T. D. Stewart (Chairman), H. L. Shapiro, T. D. McCown, W. M. Krogman. This committee, which has been selected partly out of geographical considerations, will study the contents of the proposal and report at the next annual meeting. The committee will welcome expressions of opinion from the membership.

AID FOR PUBLICATIONS IN PHYSICAL ANTHROPOLOGY

A sum of $450 has been granted to the American Association of Physical Anthropologists by the Viking Fund, Inc. for use in connection with its publications, the Journal and the News Letter. This grant, which is to be expended during 1946, is intended primarily to aid authors in the publication of extra tables and illustrations in the Journal and to defray the cost of the News Letter. It can be used also to advertise the Journal.

This grant will not permit great undertakings, but it is a step in the right direction. The Association now should endeavor to enlarge the Journal fund to encourage the use of color illustrations. One color plate, full-page, costs approximately $350.

If paper is available in good quality by the first of the year, the next volume of the Journal will appear in the old format; namely with smaller printed page and about 75 more pages per volume.

PHYSICAL ANTHROPOLOGY AND SOCIAL SCIENCES

The Second Mexican Congress of Social Sciences, which met during October adopted a resolution relating to the value and utility of physical anthropology in the study of the social sciences. This resolution, which was presented by the Section of Anthropology under the chairmanship of Dr. Juan Comas, recommends among other things: that physical anthropology be regarded in that country as of no less importance than the natural sciences in studies of basic culture and be given more consideration than at present in the curriculums of the higher educational institutions; that physical anthropologists be added to certain federal organizations; and that physical anthropology be included among those professions the members of which are required by Mexican law to meet certain qualifications before they can practice.

BIBLIOGRAPHY IN PHYSICAL ANTHROPOLOGY[1]

JULY 1, 1944 THROUGH JUNE 30, 1945

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Scheme of Classification

[1] Some items from abroad bear dates prior to July 1, 1944. It has seemed desirable to include these because they have just become available.

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